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Features & Projects

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Editorial

by Paul Freeman

It looks like Personal Digital Assistants are on their way to the shops, but will they sell in their hundreds of thousands? Amstrad are launching the first PDA onto the mass market. It may be able to take notes, memos and do calculations but will it make the tea?

Seriously though, if a personal digital assistant is effectively a mini-computer with maybe a communicator thrown in, how small can it get before it becomes ergonomically difficult to use?

We all know of the acheivements of miniaturising the technology - the calculator wristwatch is one example that comes to mind. It's fine as a toy but totally impractical for everyday use. The same goes for an alpha-numeric keyboard, if it cannot be used at speed with both hands then its use will decrease with a reduction in size. An alternative to this 'law' of diminishing returns would be to take the mechanical element out of the operation, but speech operated computers seem a long way off let-alone any futuristic eye motion operation. Can you imagine the verbal mayhem on the '7-55 to Waterloo' with everyone talking to their filofax computers.

The operational elements of a computer are now extremely small, leaving the mechical input and visual output determining the optimum size of any portable instrument. My guess is that we have reached that size with the 'laptop', and will only change when the display is taken up to both eyes providing 3D visualisation and sound activated operation.

OPEN CHANNEL

There's no doubt, the future of portable communication looks positively rosy. In the old days, portable communications was possible using standard 'phone boxes or if you needed quicker communications over a local area a grotty radio transceiver system.

Over the last few years, several new and wonderful portable communications methods have arrived on the scene. There are cellular 'phones, simple cordless 'phones for use around the house (known cryptically as CT1), longer-range cordless 'phones for use around the house or within range of a locally-based transmitter/receiver (Telepoint, otherwise known as CT2), newer personal communications networks (see later), and second generation cellular systems which have yet to see the light of day.

Now all of these must mean only good news for users. After all, in terms of competition, there seems to be rather a lot of providers, with just a limited number of users. You're not going to buy both a cellular 'phone and a Telepoint one are you? So, all these communications providers are competing against only a fixed potential user base.

Nevertheless, there are around 20 million potential users in the UK alone (given that the same number of people with plain bog-standard telephones might want to have a portable version, too). So the market, despite being limited in size, is still large. You'd think it could withstand competition from so many communications providers, wouldn't you?

Well, yes and no. The first and most important problem with this viewpoint is that users have a strict budget. They might and in most cases do weigh up the pros of portable communications against the cons of cost. Although there are 20 million or so telephone users, there is only that number because the bog-standard telephone is reasonably cheap. Portable communications - so far at least - is not cheap.

Cost rules out portable communications (apart from basic CTI-type cordless 'phones) for most potential users. Generally, only business users can afford to have cellular and other portable communications devices.

Second problem with the competition viewpoint is that, despite the cost problem, the competition in the market has not drastically reduced prices. True, cellular systems have fallen into two general price structures: one for regular users, and one for casual users. However, the casual user price structure is still really not low enough to tempt most people. Even if you rarely use the cellular 'phone (and what's the point of having it, of you rarely use it?) standing charges and so on still amount to over £300 a year. Couple this with the fact that most people already have a decent enough communications system (the bog-standard 'phone) albeit it's not particularly portable, and you can see that users have to pay twice - once for the ordinary 'phone, once for a cellular one. That's just too much for most people.

Getting the Message

Mercury is on the point of establishing one of the first personal communications networks (PCNs) in the country. These differ from cellular networks in several ways, one of which is the method of transmission and reception. Mercury, unlike the cellular providers appear, has realised the importance of low cost. Mercury's aim is to enable a straightforward portable 'phone network which can rival the landline 'phone system in price. In case you haven't already worked out the next stage, a portable system as cheap as a landline system will make the landline system very much obsolete. Who's going to keep paying for a fixed 'phone network when you can have a portable 'phone for the same price?

Mercury hopes to have its PCN working by the end of the year, but will initially only operate with the M25 area. By the end of the century it hopes to cover most of the UK.

Given the same cost as landline networks, this illustrates the real point of portable networks. While business users can and do benefit from portable communications at relatively expensive prices, home users will only use them when the cost is the same as a landline network.

No Strings Attached

Apart from cheaper personal communications there's a big move to create new communications systems between computers. It's part of the general trend towards smaller portable computers such as notebooks and the latest personal digital assistants (PDAs) about to hit the streets.

Companies such as Sony, Matsushita, Philips, AT&T, and Motorola have all invested in a company called General Magic with the intention of defining and standardising wireless communications systems for computers. General Magic was set up three years ago by Apple Computers with this very aim and, now these electronics and communications giants are involved, looks set to do its job quite soon. Software (called Magic Cap) and programming language (Telescript) are both in place and it seems to be just the question of a short time until hardware solutions will appear.

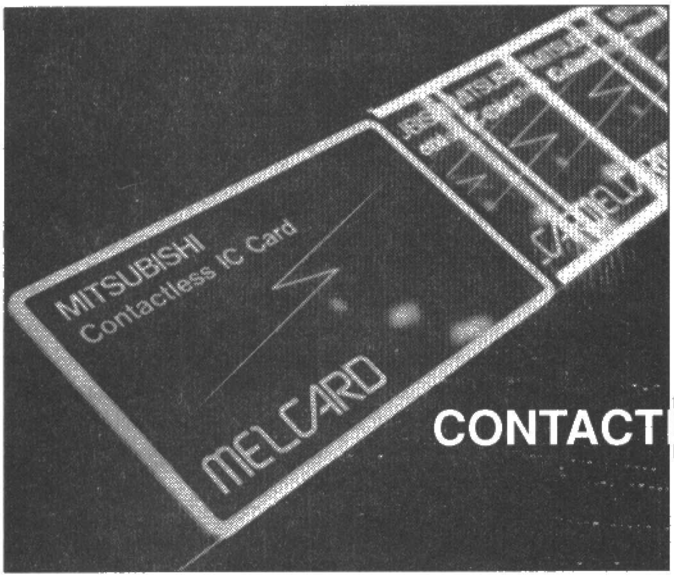
CFC's Time is Short

Recent moves within worldwide electronics industries to reduce and restrict the use of chlorofluorocarbon (CFC).

After May 15, all products sold in the States must carry a label if any substance known to destroy ozone in the atmosphere is used to manufacture the product. So printed circuit boards cleaned using chlorofluorocarbon chemicals must be labelled prior to sale. Equipment manufactured by a single manufacturer using such products has also to be labelled. However, a non-USA manufacturer who assembles parts built by another manufacturer who does use chlorofluorocarbons, is not required to label products.

In the rush to eliminate the use of chlorofluorocarbons, the Montreal Protocol, which was the original deciding factor in reducing worldwide use of chlorofluorocarbons and which was signed by all major worldwide governments (including that of the US), specifically intended to do it without legislation. St was felt that legislation would create unfair opportunities within industry. Legislating is exactly what the USA has just done, of course.

Keith Brindley



CONTACTLESS IC CARD

Mitsubishi has introduced a new contactless IC card. This latest technology provides fast access to mass user systems such as buying tickets, automatic warehousing and production control, providing authorisation for transactions and even proof of payment.

The contactless IC card operates using a read/write head linked via a controller to a computer network for data In/0ut. The card is presented near to the reader/writer head which automatically transmits data at up to 455kHz and receives at a set frequency around half that of the transmitted rate. Exact frequencies can be customised to specific applications, allowing the card to operate a ticket barrier, for example, or read part recognition data in factory automation and CIM.

Based on principles of electromagnetic inductance, the simply constructed card operates at communication distances of up to 500mm and typically operates in around 0.2s. Two versions of the card are available - one measures 54 x 85.5 x 2.5mm, weighs 15g and incorporates a five year life battery, while the other is only 1.4mm thick, weighs 10g and has a battery life of three years.

Both versions have a single chip micro-controller and communicate with the reader/writer via half duplex amplitude shift keying transmission.

Electromagnetic inductance transmission obviates the need for electrical connections, avoiding problems of dirty contacts and resultant transmission failure. It provides an ideal solution to the problems of speedily handling mass throughput.

Under extensive testing, the contactless IC card has proved highly reliable, withstanding extensive bending and torsion tests in temperatures down as low as -20°C.

ALL FORMATS COMPUTER FAIR

The organisers have made a big mistake! The venue for the London Fair on Saturday 24th April is not Sandown Park - it is in fact the Novotel, Hammersmith.

The wrong information has appeared on 1.5 million £1 off vouchers, tens of thousands of advance tickets, countless adverts and many press releases!

The organisers apologise for any inconvenience their mistake may cause.

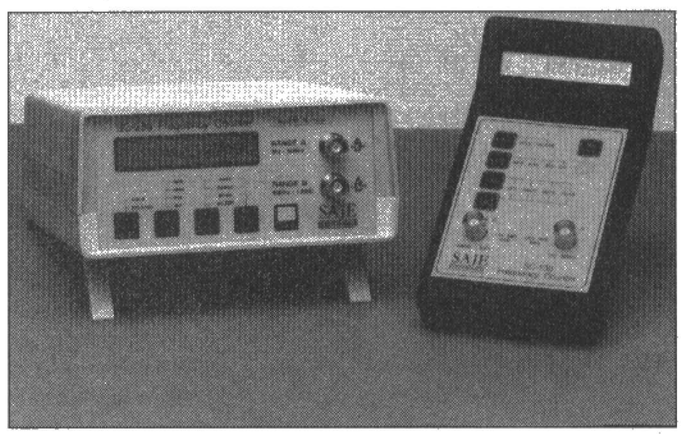
SOPHISTICATED COUNTER WITH RS232

The SC-230 frequency counter is the latest offering from Saje Electronics. Built in the UK, this micro based frequency meter has a range of 5Hz to 1.3GHz with a sensitivity of 10mV.

The SC-230 also provides multi gating rates, a view feature to display minimum, maximum, average or difference readings and a hold facility to freeze the display. Several modes are provided including count period, frequency and RPM with a low pass filter. It is priced at £149.00 plus VAT, which could make it a cost effective instrument.

For further information please contact:

Saje Electronics, Tel: 0223 425440.



RNIB LAUNCHES FIRST DAILY ELECTRONIC NEWSPAPER FOR BLIND PEOPLE IN THE UK

Judith Hann, presenter of BBC's Tomorrow's World, launched the first daily electronic newspaper for visually impaired people at the Royal National Institute for the Blind last month.

The RNIB Electronic Newspaper, was designed by RNIB in association with The Guardian and provides visually impaired people with the full text of the Guardian newspaper in a form they can independently read for themselves at the same time as a print version is delivered to their sighted neighbours. All that is required is a television aerial, a special decoder, a personal computer and a speech synthesiser or braille display.

The Guardian pages are processed to remove photographs, graphics, tables and advertisements before being coded and broadcast using TV teletext signals. The newspaper is divided into sections according to subject, so readers can browse through the headlines and choose which article they want to read. The system also gives full access to BBC and ITV teletext services and the sound of all four channels can be provided via external speakers or headphones. The minimum cost for the system is £560, which includes installation of the decoder and a one year subscription to The Guardian.

ETI first reported on the pilot system three years ago and since then a number of recommendations, which were made by users on the pilot scheme, have been implemented.

For further information please contact: Kevin Johnston, RNIB, Tel: 071 3881266 ext 2320.

COUNTDOWN TO PHONEDAY BEGINS

A campaign to prepare customers for changes to national and international dialling codes has been launched by BT.

The changes, announced last year by the Office of Telecommunications (Oftel), will take place at Easter 1995 - more than two years away. BT is starting its publicity campaign now, however, so that everyone is ready for Phoneday.

The changes follow extensive and lengthy consultation by Oftel with representatives of telephone users, operators and equipment manufacturers.

They will create the additional codes and numbers which are needed to cater for the rapid growth of telecommunications services well into the next century and provide capacity for any new operators entering the market. Advertisements appearing in the national press marked the beginning of a two year communications programme, while a Phoneday logo has been developed to help publicise the event and raise customer awareness

Phoneday is Easter Sunday, April 16, 1995, when an extra digit, 1, will be added after the initial 0 of area dialling codes. Five cities - Leeds, Sheffield, Nottingham, Leicester and Bristol - will be given new codes and the international dialling code from the UK changes from 010 to 00.

Alan Croft, BT Phoneday project manager, said: "Oftel, telephone users and the industry chose these changes as the best way forward. Obviously we regret any inconvenience to customers, but the timing of Oftel's announcement gives everyone more than two years to plan for the changes. BT's aim will be to minimise any cost and inconvenience by ensuring that everyone is well prepared.

"We have researched the specific needs of our business and residential customers and we will be providing them with the information, advice and practical help they need, when they need it."

The first phase of the campaign will address the specific needs of businesses and certain trade sectors who need to plan well in advance of the actual changeover date.

Communications managers will be contacted about reprogramming telecommunications and computer equipment which store numbers in memories or bar calls to certain destinations.

Businesses will also be advised about planning changes to stationery and other literature. Specific messages will be addressed to Operators and users of security and care alarms which report to distant monitoring centres. Many existing alarm systems will need to be reprogrammed to dial the correct new code and account will be taken of the special needs of vulnerable groups such as disabled customers and old people.

Anyone wanting information about Phoneday can phone BT's free helpline on (0800) 010101.

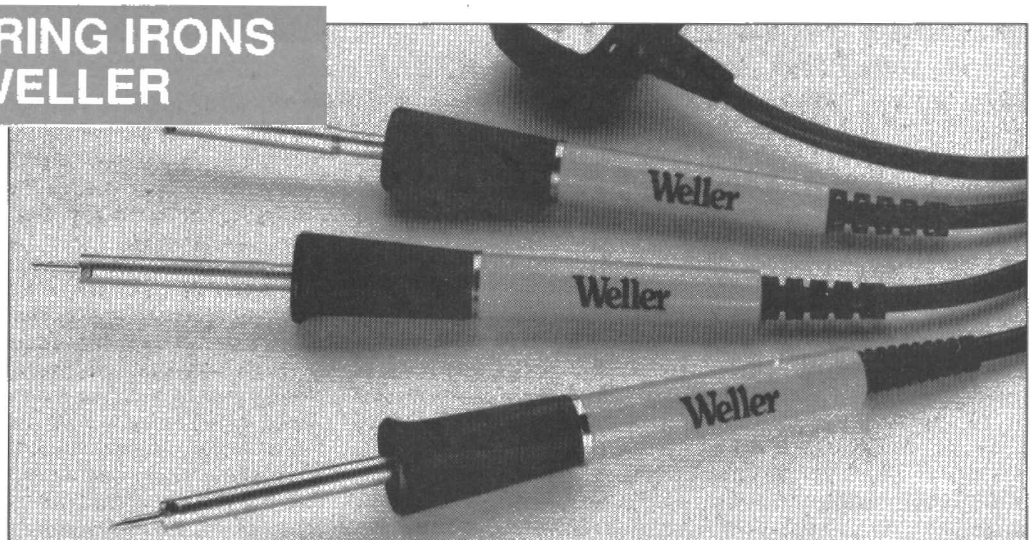
NEW 64K ELECTRONIC ORGANIZER

The new 64k Electronic Organizer and Diary from Maplin Electronics is a multi-function electronic organizer which features 64k of memory and a large, 8 line dot matrix display (256 characters) with 5 x 7 font. The memory can store approximately 1400 names or 850 appointments, while names and telephone numbers can be recalled by direct, sequential and repeat data search methods.

The Organizer has a qwerty-style keyboard and many features, including appointment reminder with calendar alarm, anniversary reminders, daily alarm for three daily events, world time and weather data. A 'secret' feature is available with up to eight characters for security protection of telephone data, a calculator, imperial/metric conversion, currency conversion (user selectable), direct or sequential search by name or company information, infra-red data transfer and auto-power off after 8 minutes.

The price is £89.95 (to include VAT).

MINI SOLDERING IRONS FROM WELLER



Cooper Tools, manufacturers of Weller soldering equipment, have introduced a new range of mini, lightweight soldering irons.

The Weller Mini Series 2000 provides a choice of seven different soldering irons rated at 12, 15 and 20Watts.

The new mini irons have long lasting nickel soldering tips and all models come complete with moulded-on 13-amp 3 pin plug.

For further information contact: Cooper Tools, Tel: 091 4166062

COMPUTING & ELECTRONICS COMPANIES STILL FAILING TO BRING NEW PRODUCTS TO MARKET

Companies in the computing and electronics sectors are still missing opportunities to gain competitive advantage through speedier new product introductions, according to an executive briefing from Coopers & Lybrand. Three years ago, over 60% of companies in the industry said that the inability to bring new products to market quickly was the most significant factor limiting company performance.

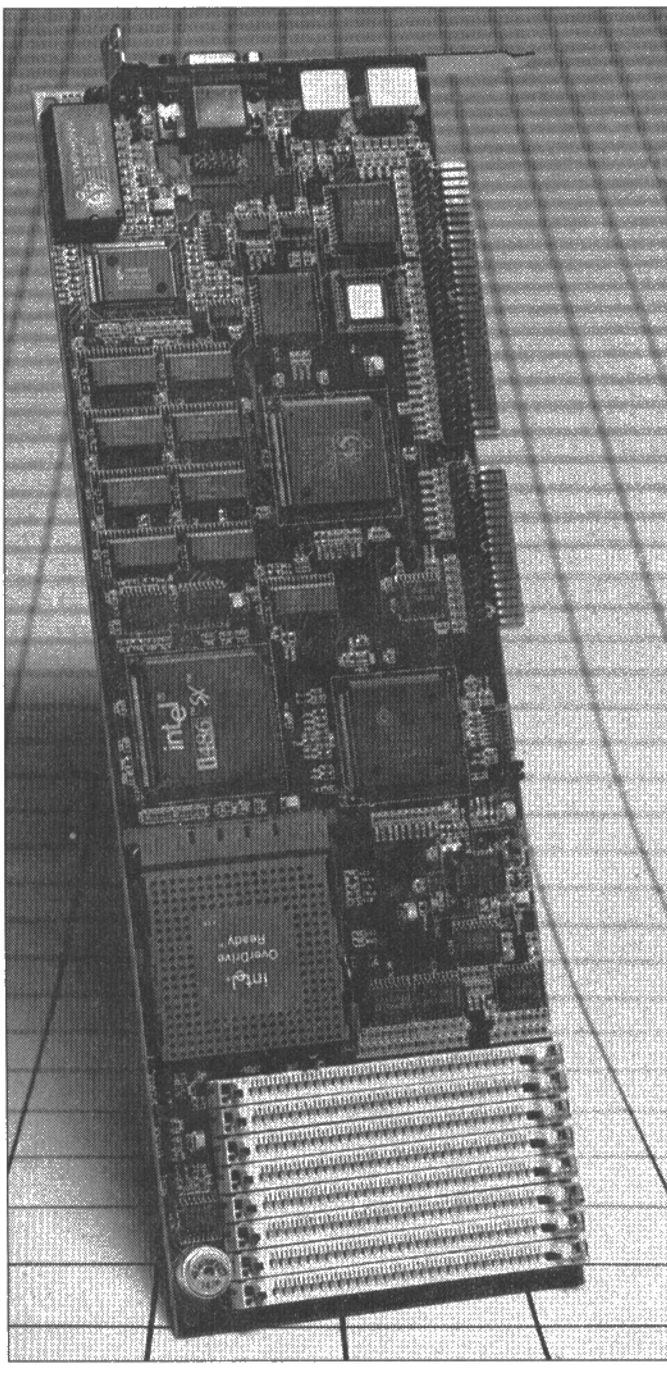
Despite implementing improvement programmes across a range of business practices, 57% of these companies still cite speed-to-market as the single most limiting factor today.

Despite widespread understanding of the principals of simultaneous engineering, the brief claims that difficulties in implementation are resulting in a loss to industry of potentially major improvements in speed-to-market, engineering cost reduction, productivity gains and increased customer satisfaction.

CHEAPER MODULAR PCS

A British company has come up with a new design for CPU boards and back planes, intended to bring low-cost modularity to the personal computer market for the first time.

Array Technology of Camberley has introduced the CAT series of modular units in order that the price-sensitive PC OEMs and users can share the benefits highlighted in industrial controls applications.



This CPU board, the first to be launched by Array, is less than 20% of the cost of modular cards used in industrial controls. The Cougar AT CPU board is a high performance 486SX/DX designed to be loaded into an active backplane. It is available with a 486SX-20 PQFP processor and no cache, all the way up to a 66MHz 486DX2 with 1 MByte cache.

"The development allows the PC to break free from its home computer parentage and take advantage of true state of the art technology to the benefit of manufacturers and users alike," says Array Technology Managing Director, Paul Johnson.

Johnson is committed to rolling back the tide of "inflexible" Far Eastern imports and has already begun shipping Cougar to a number of European OEMs.

Cougar is the first of a series of CPU boards, graphics cards and backplanes being launched over the next few months. Further information is available from Array Technology, Tel: 0276 691798.

SINGLE-ELECTRON MEMORY POSSIBILITY

A team of Japanese and British scientists, working at the Cavendish Laboratory, Cambridge University, have published research which, for the first time, demonstrates that one bit of information can, in principle, be stored by just one electron in a semiconductor memory.

The implications of a single-electron memory for the future commercial production of semiconductors and therefore for the electronics and computer industries, are enormous, as it represents a first step towards the manufacture of chips with vastly increased memory capacity but without any associated increase in power consumption.

This breakthrough is the result of the collaboration, begun 1989, between researchers from the Hitachi Cambridge Laboratory (HCL) and the Microelectronics Research Centre (MRC) of the Cavendish Laboratory. The joint venture is funded by Hitachi and it is believed to be the first time that an Anglo-Japanese team has made such a breakthrough in the field of semiconductor devices in the UK.

Dr Kazuo Nakazato, HCL's senior researcher, explained: "At present, 16-Mbit memories consume around 0.1W. If we were to construct a 1-Tbit memory using conventional semiconductor technology, the power consumption increases to 10kW which would be impossible to dissipate in a mobile computer. In a single-electron memory, by contrast, consumption for an equivalent memory size would be less than 0.1W.

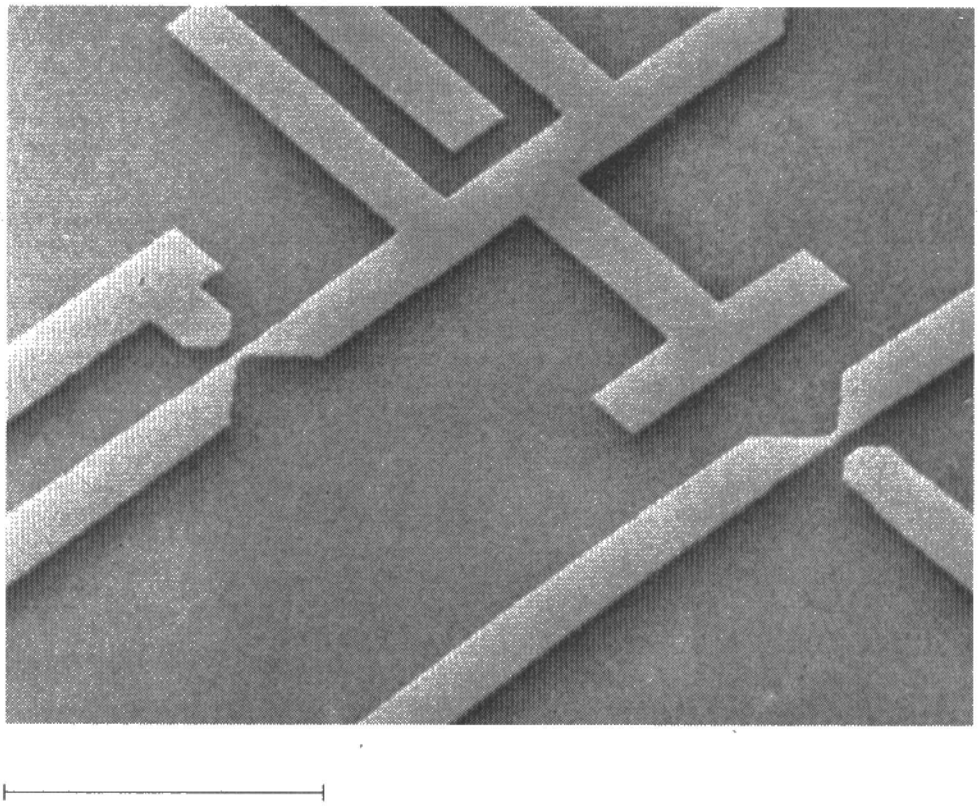
"In addition," he continued, "the space required for a 1-Tbit memory will be reduced 100,000 times. So, while today's technology means that an area larger than a tennis court would be needed to hold a 1Tbit memory, a single-

electron memory would reduce that area to something approaching the size of a fifty pence piece."

Conventional 16-Mbit semiconductors need around 500,000 electrons to store one bit of information and only an average number of electrons can be controlled. In a single-electron memory, however, individual electrons are fully controlled, with a precise number of electrons present or absent in a memory cell.

Scientists around the world have been aware for some years that a single-electron memory is achievable, but the Cambridge team's work is the first to demonstrate the concept.

"There are many practical problems to overcome in producing a commercial single-electron semiconductor memory," said Haroon Ahmed, Professor of Microelectronics at Cambridge University and team leader. "However, it is feasible that within 20 years, if single-electron memory chips are produced, they will allow PCs to perform the range of functions and store the quantities of data currently only possible using huge, mainframe computers."



"We invest around three-and-a-half million pounds each year in research and development programmes in Europe, of which around one million pounds goes into funding the Hitachi Cambridge Laboratory," said Akira Koizumi, Managing Director of Hitachi Europe Ltd.

"In today's world, where technology has become so complex, R&D can only be successfully undertaken in the context of global, collaborative research. The realisation of a single-electron memory by the Cambridge team provides important justification for Hitachi's belief in joint research undertakings which can make profound contributions to the progress of science and technology in Europe - and throughout the world," Mr Koizumi said.

GLOBAL SMART CARD COVERAGE AIM

German electronics giant Siemens has signed a long-term agreement with McCorquodale Smart Card Systems (MSCS) to license its Smart Card operating system software for distribution throughout the world, including former Eastern Bloc countries.

The endorsement is the latest confidence boost for the recently established Bowater company, MSCS, and signifies a serious commitment from Siemens to the development and success of the emerging Smart Card industry.

Already, Siemens and MSCS are working together to develop new chip technologies specifically for Smart Card use. An integral part of the contract is a new microcontroller line designed by Siemens, using submicron CMOS technology and one of the world's fastest encryption techniques for chip card applications. It is hoped that reinforced market presence will increase awareness of the technology and put greater pressure on certain sectors to speed up the introduction of Smart Card systems.

MSCS is currently pursuing contracts in a variety of market sectors including banking, retail loyalty, health care and security. A range of card technologies is offered by the company, which launched Europe's only 16-application Smart Card earlier this year.

MSCS manufactures cards in the UK and the company also has distributors in Scandinavia, Spain and Ireland, agents in North Africa and the Middle East, and strategic links in the United States, Brazil, South Africa and Australasia.

WOMENS TECHNOLOGY SCHEME

The Women's Technology Scheme (WTS) based in Liverpool is celebrating its first 10 years of helping women to break into the world of high technology.

On March 5th, there was a special Birthday Party at the Philharmonic Hall, Liverpool. Guest speakers included Jenni Murray, presenter of Radio 4's popular 'Woman's Hour', the Lord Mayor of Liverpool, Rosemary Cooper, and MP, Jane Kennedy.

The Irish President, Mary Robinson, has joined in the plaudits: "I send my warmest congratulations to you on your wonderful achievements and my very best wishes for the future," she said.

Despite a growing need for technological skills, women find it hard to gain access to training. Less than 3% of scientists, technologists and technicians are women, and 94% of women in engineering are at the lowest grades. The WTS is striving to change those depressing statistics by offering realistic vocational training, built around the fundamental needs of women.

WTS aims to redress the imbalance in technology training for women, thus broadening and strengthening employment opportunities.

The scheme evolved from the ideas of a concerned group, aware of a lack of training for women which was related to their needs and to those of local employers.

The Scheme is funded by Liverpool City Council, Merseyside TEC, the European Social Fund, and the government's City Challenge Initiative.

ETI NEWS ...Stateside...

All optical signal path

What is claimed to be the first general-purpose optical computer that uses an all-optical signal path has been built at the University of Colorado. Electronic latches for synchronizing bit streams are eliminated by "storing" the streams in fibre-optic loops.

Unlike AT&T Co.'s efforts of a couple of years ago - in which simple computational blocks performed tasks like counting and decoding - the bitserial optical computer manages 16-bit words, one bit at a time. It can execute a stored computer programme based on a repertoire of instructions.

The BSOC, which has a 1,024-bit main memory, two counters, an arithmetic and logic unit, three temporary storage registers, and a complex systemcontrol unit, was built at the University's Optoelectronic Computing Systems Centre. The centre is designing a palm-sized version of the machine that will be 400 times faster than the current 50MHz BSOC. Applications are seen in telephone, data communications, cable television and virtual reality.

A virtual-world software component called a human interface for interaction between virtual-world databases and standard hardware has been developed at the Human Interface Laboratory (Hit Lab) of Seattle, Washington, dubbed Mercury, the software helps immerse participants within a virtual reality and responds to their actions there in real-time.

The interface is available to all members of the Hit Lab, a roster of major computer and communications companies. These companies constitute the Virtual World Consortium. The Hit Lab also plans to make Mercury available to non-members through a licensing programme.

Mercury propels participants into virtual worlds by putting together various pieces now available from separate vendors. The software shuffles input from sensors to virtual-world databases and collects images and sound from the databases for output to the participants. The virtual-world databases can be user supplied or can be encapsulated by the Hit Lab's Virtual-Environment Operating System.

Mercury handles all rendering task management, including stereo images (one for each eye) and binaural sound (four-channel), to create a three-dimensional virtual space. When used with conventional flat-display devices and stereo headphones, it automatically translates three-dimensional objects for the two-dimensional media.

Available processors routinely split the image-rendering tasks. Sound is managed over a separate musical instrument digital interface to permit integration of live, recorded and synthesized sound effects.

Mercury accommodates any type of tracking and orientation sensor via plug-ins for any six-degree positioning device - from radar-based position sensors to electronic gloves and 3D trackballs. The data from sensors is fed to the visual and auditory display systems and then back to the virtual-world database to inform it of the participant's current activities.

Mercury is written entirely in C and currently runs only on high-speed Unix-based workstations, but can be easily ported to other platforms with similar horsepower.

Non-linear transmission line gated sampling circuits

Research workers at the University of California are developing nonlinear transmission line gated sampling circuits that they believe will pave the way to making Terahertz test and measurement instruments.

Fabricated on standard GaAs wafers in a five-mask process, the new sampling circuits offer a simple solid-state alternative to advanced measurements systems based on femtosecond lasers. The researchers are using the NLTL-gated circuits in a prototype test system for millimetre-wave analogue components.

NLTL-gated devices are based on a GaAs transmission line that is periodically loaded with reverse-biased diodes. The diodes compress the negative side of a sine wave to generate shock waves with a 1.8ps fall time. The resulting output, a sawtooth wave with 4.5V amplitude, is used in two different ways to test materials or circuits. For circuit testing, the signal is fed to a probe tip that can be placed at specific points in a circuit. A second probe acquires the signal at some other point and feeds the result into a receiver NLTL device, which then decompresses the signal for analysis.

The result is a high-frequency electro-optic spectroscope that is useful in characterizing semiconductor materials. The receiver side of the system could also be used to analyze the output from millimetre-wave circuits.

The director of the project is confident that a twofold to threefold increase in NLTL speeds will result from the current research. The performance of the probe tips has been more of a problem, however, because of parasitic capacitance between the tip and the circuit under test. The University of California is looking for better materials to reduce that problem, and also for a structure that will be durable and reliable under repeated use.

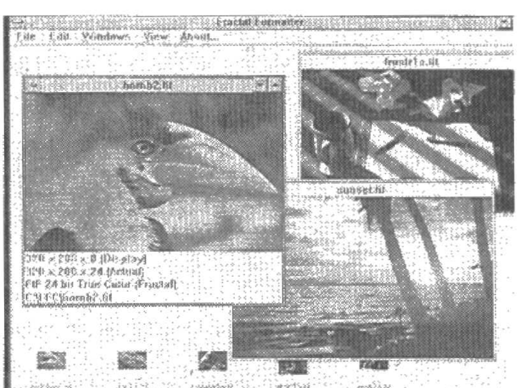
Compressing digital imagery

Iterated Systems Inc. has recently harnessed fractals to compress digital imagery. Previously available only for systems with expensive hardware accelerators, the new Pictures for Original Equipment Manufacturers (POEM) ColourBox offers software-only fractal compression and decompression to software developers.

Packaged in the form of a dynamically linked library for Windows, developers use it to incorporate real-time compression and decompression into their programmes.

POEM ColourBox can compress images by 10- 600fold, with a 10-to-1 compression of a 320 x 200-pixel image taking 36 seconds on a 386-based PC and 11 seconds on a 486-based machine PC. Images up to 768 x 640 pixels can be compressed in a single session, with larger images tiled and compressed in multiple sessions. The company recommends one of its accelerator boards for applications involving images larger than 640 x 400 pixels.

Decompression is always faster with fractal technology. Decompressing a 320 x 200-pixel image, the POEM ColourBox takes just 3 seconds on a 386 PC and 1 second on a 486 PC.



Ordinary image-storage mechanisms record a rectangular array of colour values - one for each pixel. Those colour values are mapped onto the pixels of the display. All is well if the number of pixels in the image match the number of pixels on the display, but zoom in or out and there will inevitably be a mismatch, necessitating either throwing away over-abundant pixels or adding redundant ones. In either case, the image distorts.

Images compressed with this fractal transform technology can be recreated not only at the orginal and smaller magnifications, but also at larger sizes than the original - called resolution enhancement.

READ/WRITE ETI Letters

Spotting The Fault

An engineer working within a repair centre often spends a great deal of time probing around a board in an effort to trace a faulty signal back to its source.

On occasions, however, the alert engineer may notice that a component is unusually hot to the touch. Upon replacing these components, a cure is found without having to 'signal trace', thus saving a great deal of time for the repair department. In my experience this occurs in roughly 8% of cases.

Clearly, a 'resistive short' has developed internally to the component, or sometimes the amount of heat generated is enough to physically blow apart the component.

More often than not, the faulty component, once located, does not feel unusually hot as although a resistive short may have developed initially, the amount of heat generated was so intense that the short was literally melted, leaving an open circuit within the component.

This is very similar to the principle used in fuses. Under normal conditions, a fuse will feel warm to the touch. Under heavy load conditions the current generates so much heat that the fuse melts away and for a brief period, the fuse will be unbearably hot to the touch.

In some component failures, it may be that an excessive amount of heat is not generated during the failure. It may also be that some component failures are so catastrophic and sudden that the relatively very large thermal mass of the average IC does not have time to heat up.

It is quite reasonable to assume that at least some component failures do lead to excessive heat generation over a period of time sufficient for the component body to heat up briefly, before cooling. These failed components will give no indication of their failure to the repair engineer and will have to be located using traditional fault finding methods.

If it could be demonstrated that these types of failures represent a significant proportion of all component failures, it may be of use to spot the ICs on a board after manufacture and test using one of the new thermal indicating paints. These paints remain opaque until a specific temperature is reached, after which they remain translucent.

While the idea of fault finding with a dab of paint may appear rather, hopeful it is worth remembering that all components carry electric current and therefore obey the law Power = Potential Difference x Current. Any change in activity within the component will result in a change in the ambient temperature of that component.

Even if only 15-20% fail in this fashion, the amount of time saved in fault finding may make this a practical proposition.

A Peirson,
Luton,
Beds

Mains Safety

I have been a regular reader of Electronics Today International for thirteen years now and, although the interest and inventiveness of the projects has remained good (despite the quantity being reduced somewhat and the latest Tech Tips being mainly repeats), I am appalled at the electrical safety of some of the projects that have been presented in 1993. Whilst the clearance and creepage distances between live and earth on the printed circuits in Magnus Pihl's Disco Amiga fall a long way short of the 3mm required by 85415, the main culprit is Ken Blackwell with his IR controlled dimmer. With or without the corrections in the March issue, his project is potentially lethal and I would strongly advise anyone against building it.

BS415 treats both neutral and live as being potentially live, as reversal of the two is not uncommon, especially in lighting circuits and does not lead to the apparatus not working. It requires insulation between live/neutral and earth which will withstand 2.5kV peak AC. I don't know how the IR receiver hopes to achieve this with a diode between neutral and earth. Although the corrections state that the terminal block should be changed to a two way live/neutral terminal block, it makes no mention that the circuit should no longer be connected to earth (the circuit diagram shows an earth symbol as well as the earth terminal of the terminal block). If the earth connection remains, an accidental reversal of live and neutral will result in the destruction of the bridge rectifier. With live and neutral connected correctly, part of the bridge rectifier will be redundant as neutral and earth are connected at the PME point where the mains supply enters the house and the circuit will also allow enough current to earth through the power supply to trip any RCCB to which it may be connected.

Assuming that the earth connection was to be removed, the circuit in operation will connect the touch pad to mains neutral. If the house has no PME (as some older houses do not), which could put the touch pad at potentials up to about 50 Volts. If, however, live and neutral were reversed, the pad would be directly connected to 240V AC, which could prove fatal to anyone who happened to touch it at the same time as the remote control was being operated.

My advice to Mr Blackwell is that he should stay with battery power supplies until he has mastered the art of mains derived supplies. The obvious choice for this project would be a low voltage isolating transformer. Quite how Mr Blackwell's transformer generated radio frequency interference whilst operating at 50Hz I am not sure, but solving the problems of transformer interference (which I presume was of a magnetic nature) would have proved far safer to your readers than attempting to build a capacitive-dropper supply.

I am not sure what Mr Blackwell hopes to achieve by the inclusion of L1: in practice it produces a series resonant circuit at either 13kHz or 18kHz (depending on his final choice of capacitor), the impedance of which drops to zero at the resonant frequency, leaving only the 47R resistor in line, at a frequency which corresponds nicely to the interference on the mains caused by switched-mode power supplies. How he managed to get the circuit to work reliably with a 250V DC rated capacitor, as in the picture on the front cover mystifies me - obviously it was not tested for long.

Whilst I would not expect every circuit that is sent for publication to be checked to see that it would work as described, I would consider it the duty of the editor to check projects for basic electrical safety before publication, especially in cases where free printed circuit boards are given away to encourage readers to construct the project.

Ian Benton,
Ilkeston,
Derbys.

I agree that safety is of the utmost importance when dealing with mains electricity. Suggested modifications to the earth/neutral problem were published in the March issue. Anyone experimenting with the circuit should check first with a qualified electrician that everything is OK.

On the positive side, the circuit was published because, as a prototype, it is interestingly different, a point made at the beginning of your letter. Part of the reason for a transformerless supply in this project was space limitation - the project was designed to fit in a mains electrical box.

The most common mains transformerless appliance is the television. and was designed this way in the interests of reducing bulk and costs. - Ed.

Dog Repellers

Over the years there have been a number of ultra-sonic audio generators proposed for repelling dogs, rodents and even people. A 'Shoo Dog!' circuit appeared in Elektor '300 Circuits', published in 1979. This circuit is a answer to the doubters who denied the existence of such circuits and there have been two or three others published since. I have vague memories of one magazine having a PCB for such a circuit within the last three years.

Guy Selby-Lownes,
Billinghurst,
West Sussex

Symbol Conventions

Following my recent purchase of the March 1993 issue of ETI, I see that you are inviting comment on the circuit diagram symbols used in the magazine.

For the record, my own preference is for a hybrid of the two options offered and is as currently used in Elektor with box resistors but transistors shown in circles.

I am a little hesitant about the new style logic symbols, although I am sure that it is only a matter of time before I become accustomed to these.

Finally, may I express my pleasure at the return of the Automate Mixer series (although part 9 seems to have escaped since the series leapt from 8b to 10a). I hope that no further interruptions will occur before the series is concluded.

Tony Crane,
Kings Lynn,
Norfolk.

You spotted the numbering anomaly. Part 9 of Automate (switching circuits) has been held in cold storage. It will appear next month.

With reference to your readers' ideas about circuit conventions, I have just one criticism of circuit presentation.

Circuit junctions should always be staggered and emphasised with a dot. This is especially important when photocopies are made because the dot can be lost and the join misread as a crossing. The old-fashioned method of showing crossovers with a loop is probably best forgotten. As for other conventions, I prefer wiggly lines for resistors but I'm not particularly worried either way.

Gordon Pope,
Hampstead,
London.

Having read the letter from J. Treeby in the March 1993 issue, I can only agree wholeheartedly with his comments. I bought my first copy of ETI in 1974 and had not looked back, but lately, more typos have been slipping in and then you started producing circuit diagrams on DTP. Suddenly, the superb clarity we had come to know and love became scruffy and unclear, with components all out of proportion. Our hobby is already full of anonymous boxes and confusions, so wouldn't it be better if ETI returned to being an oasis of clear meaningful diagrams in a desert of little boxes? Bring back the old circuit diagrams!

Stephen C. Varley,
Cheltenham,
Glos.

Printed Circuit Transparencies

Although I use a computer with Easy PC Software to design and print transparencies, my problem is that I only have a dot matrix printer to lay a circuit on to a transparency. This doesn't work in practice, as the contrasting dark areas are too transparent to put under an ultra-violet light.

I could have purchased a laser printer or a graphics plotter, both of which are expensive, or used black etch transfers, a time consuming business, but there is a fourth solution that is both cheap and practical.

I now use A4 draughting film sandwiched between two sheets of inward facing black carbon paper. Using a bold print selection from the computer, the dot matrix printer gives first class high definition prints. The density is even high enough to allow the use of an Ultra-violet exposure unit. For etching the developed boards I only use a clear etchant. This allows you to watch the etching progress when using a bubble tank, eliminating the chances of over exposure.

Multicore Copperset PTH Kit

A review by Andrew Armstrong

REVIEW

The purpose of the Copperset PTH kit is to provide a means to simulate the effect of a plated through hole in a PCB. It contains three diameters of thin copper tube, scored to break at lengths equal to the standard thickness of a PCB.

The tube is supplied filled with solder, which may be removed with a solder sucker, or with the desolder braid supplied, after installation. The tubes, referred to as 'bail bars', are made by plating 25 to 30 microns of copper on to solder wire (without flux) and then plating with a thin layer of tin to prevent corrosion.

To fit a bail, you must ream out the PCB hole to the correct size. Three drill bits fixed in colour coded plastic handles are provided for this purpose. I do not know what the bits are made of, but they seem hard enough that they won't wear out too quickly.

When the hole has been reamed, the bail is inserted using the insertion pen supplied, which is colour coded to identify the correct diameter. The bail is then formed to make a tight fit using the punch and anvil supplied.

This procedure is sufficiently time-consuming that I would not recommend it where dozens of plated through holes are needed, but there are occasions when it is invaluable. I delayed writing this review until I had an opportunity to use the kit for serious work, so that I could test its efficiency in earnest.

Eventually, a control chip on a prototype switched mode power unit failed and I needed to replace it. Despite all my care in removing the failed chip, one of the plated through holes was damaged. Inevitably, this hole connected to a top track running under the IC. One can repair this type of break by linking from top to bottom with a thin piece of wire, but the PTH kit allowed a neater and easier repair. It did prove difficult to get an ideal position for the anvil, with other components in the way and because I dropped one of the tubes while trying to fit it, but it was well worth while to achieve a clean and invisible repair.

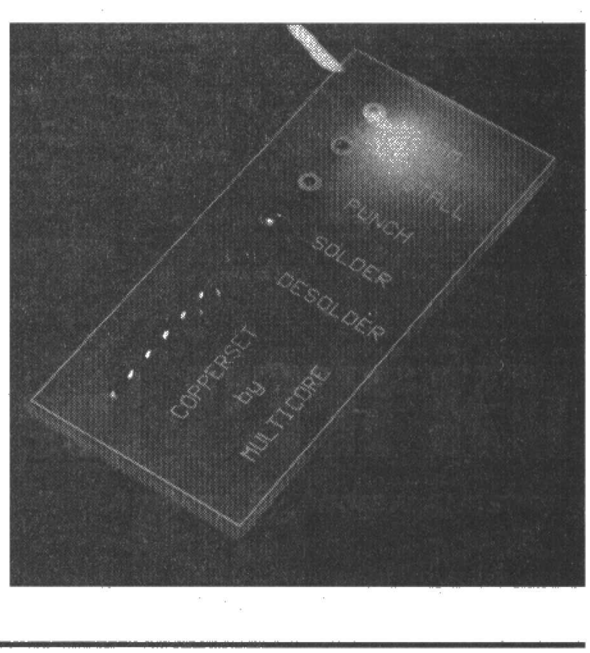
The PTH kit seems to have two main uses. It appears to be designed mainly for use with home made or in-house prototype PCBs but will also enable repairs to be made to purpose-built PTH boards. For PCB repair, an anvil with a finer point is supplied, but even so it can be difficult to fit between closely packed components.

When designing for amateur construction, or for an in-house prototype, it is often possible to allow an extra pad to place a link from top to bottom with a track pin or piece of tinned wire. However, there are some areas where this is impossible and the Copperset PTH kit offers a much more reliable solution for these cases than simply top-soldering a component pin. It also makes it possible to change a component without the serious risk of tearing off the top track to which it is connected.

Even if a separate top-to-bottom link is being used, the Copperset kit can make the via connection in a smaller diameter than can a track pin and is quite practical to use with a 50thou pad to make via connections. With skill, it will work with 40thou pads (the smallest hole size needed is 31thou). The downside to this is that track pins are quicker to insert, so may be preferred where there is no space constraint.

The kit contains three sizes of bail bars, three reamers, three insertion tools, a punch with three nose-pieces, an anvil base with two anvil bars, thin wire to link tracks where pads have been destroyed, solder and desoldering braid. The only other item required is a soldering iron, though a solder-sucker is also useful.

I'm not sure that I would have been motivated to buy this kit simply on the strength of press advertising, but now that I have tried it I find that it is well worth having and I shall continue to use and maintain mine.



The Fuzztone

ETI
Cover PCB
Project

An easy-to-make fuzz box for your guitar by Daniel Coggins

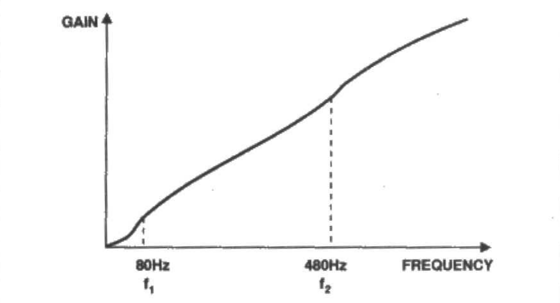


Fig.1 Frequency response of fuzz box

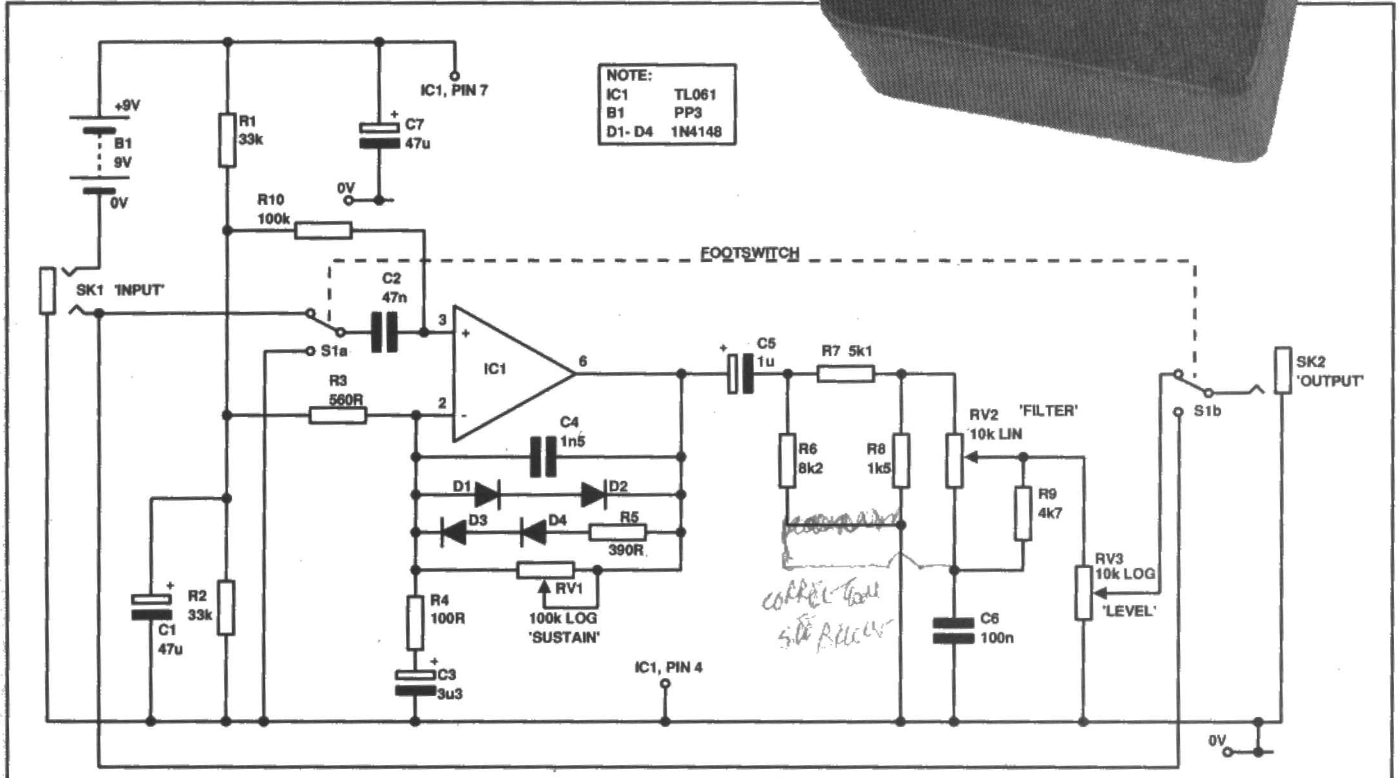


Fig.2 Circuit diagram

Over the years, many designs for distortion pedals (also known as fuzzboxes and overdrives) have appeared in the pages of electronics magazines and there are countless models available on the market, all of which seem to claim to sound superior to the rest. This design was borne out of an experiment by the author (a guitarist with experience in electronics) to make a distortion pedal that could give a useable, controllable sound with as simple a design as possible. When the prototype was tested, it was found to give an impressive range of sounds, which could easily rival some of the more expensive pedals available in the shops and certainly makes a viable project.

 ERROR / CORRECTION FROM ETI JUNE 1993 P.61 OOPS!

Built from readily available parts, it is straightforward to construct, and features controls for sustain (the overall amount of distortion, or 'drive'), a filter control (to provide varying degrees of high frequency harmonics, giving a wide range of tonal variations) and a level control to match up the 'straight-through' sound and distorted sounds, when the foot-operated switch is pressed.

Design considerations

Several considerations were made at the design stage, from a musicians perspective, namely that the unit must have battery operation with minimal current consumption (this design uses about 300µA, which is very low and will give long life from a PP3 battery). Also, the input jack must switch the unit on and off when the guitar lead is plugged in or removed respectively.

Finally, and perhaps most importantly, the unit must give a range of easily controllable and useable, musical sounds. All too many fuzzboxes, despite giving lots of sustain, can sound weak and fizzy, due to the high proportion of odd order harmonics produced by the clipping in the circuit. By simply adding a tone control, most of these can be removed judiciously, leaving the low to mid frequencies intact, which results in a rounder sound, more akin to that of a valve amplifier being pushed into overload. This design does not pretend to emulate a valve amplifier sound - there is no substitute for the real thing - although it does go some way to approaching this by virtue of two features; asymmetric clipping, which increases the dynamic range of the effect and a midrange boost which adds 'body' to the sound. These features are explained in the 'How it works' section.

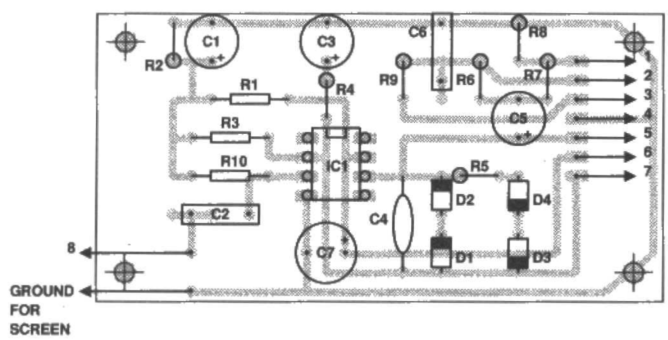


Fig.3 Component Overlay

Construction

This should be quite straight forward. First, assemble the components on the PCB starting with the resistors and capacitors (double check the polarity of C1, 3, 5 and 7), followed by IC1 and D1-4. Take care when soldering these, ensuring that they don't get too hot, and again double check their polarities (see overlay).

HOW IT WORKS

In principle, the sound of a guitar (or, indeed, any musical source) can be distorted by over-amplifying it and using the circuit's limit to clip the signal. In practice, the results are governed by how it is clipped. If valves are used, their distortion will sound different than that of their solid state counterparts. This design uses an operational amplifier IC, providing high signal gain, with a diode clipping network, to square off the complex signal and thus distort it. This waveform can then be modified by the rest of the circuit.

CIRCUIT DESCRIPTION

The supply taken from the battery is decoupled by C7 and split and decoupled by R1, R2 and C1. IC1 is configured as a non-inverting amplifier with adjustable negative feedback. The ratio of the 'Sustain' control, RV1 and resistor, R3, sets the gain between zero and several hundred. Resistor R10 sets the input impedance to 100k, which works with most guitars to provide the correct response to adjustment of the guitar volume control, to clean up the distortion if desired. The incoming signal is either switched via coupling capacitor, C2, to the circuit, or bypassed to the output, directly - with no loss of clean signal, which is often a problem with some pedal designs. The frequency response of the circuit is tailored by R4 and C3 to give an increase in gain above about 480Hz, and in conjunction with R3, gives a slope between about 80Hz and 480Hz, with much less gain below 80Hz. This has the advantage of rejecting 50Hz mains hum to a degree (remember, this is a sensitive high gain circuit, hence the screening from the diecast case). This also makes the unit very effective with bass guitars, where the fundamental notes can be as low as 40Hz and can cause a rather confused sound. This unit works by mainly distorting the upper harmonics of the fundamental.

Clipping, and hence distortion, is achieved by connecting an anti-parallel network of cascaded diodes across the feedback loop. Capacitor C4 filters out the high-order harmonics, which sound very brittle and unpleasant. It also doubles as an RF bypass capacitor, to avoid the unit picking up Radio Moscow after dark. Four diodes are used to give a larger voltage swing on the op-amp's output (up to 1.2 volts p-p) which gives greater headroom and plenty of level to drive the passive filter and volume controls that follow it. Another benefit of this is to provide sufficient output boost to overdrive the front end of a guitar amplifier, if so desired.

A resistor, R5, is added in one of the diode branches in order to offset the clipped waveform. This asymmetric clipping is beneficial in musical terms, as it not only allows greater headroom of the original waveform on alternate half-cycles (this goes some way to preserving the original tone), but also encourages generation of even harmonics, not unlike an overdriven valve amplifier. The effect of this is to give a more 'responsive' design, which most guitarists will feel is desirable.

The output of the op-amp is coupled via C5 into a passive filter network. Resistors R6, 7, 8 and 9 ensure that the overall sweep of the control is relatively even. Capacitor C6 filters out the high frequencies, and the blend of frequencies can be selected by setting the potentiometer, RV2. Finally, the required output level is adjusted with the 'Level' potentiometer, RV3.

As an aside, readers may wish to experiment with the sound of the unit by altering the values of R3, R4 and C3. Overall gain is set by R3, so by reducing its value, gain is increased and vice-versa. By choosing values for R4 and C3, the overall frequency response can be 'tweaked'. Use the following formulae to achieve this:-

$f2 = 1/R4 \infty C3 \infty 2\pi$ where $\pi = 3.14$

This gives the upper boost frequency. The lower frequency where the slope starts is given by :-

$f1 = 1/(R3+R4) \infty C3 \infty 2\pi$

As C3 effectively 'sees' R3 in series with R4 (see diagram of frequency response).

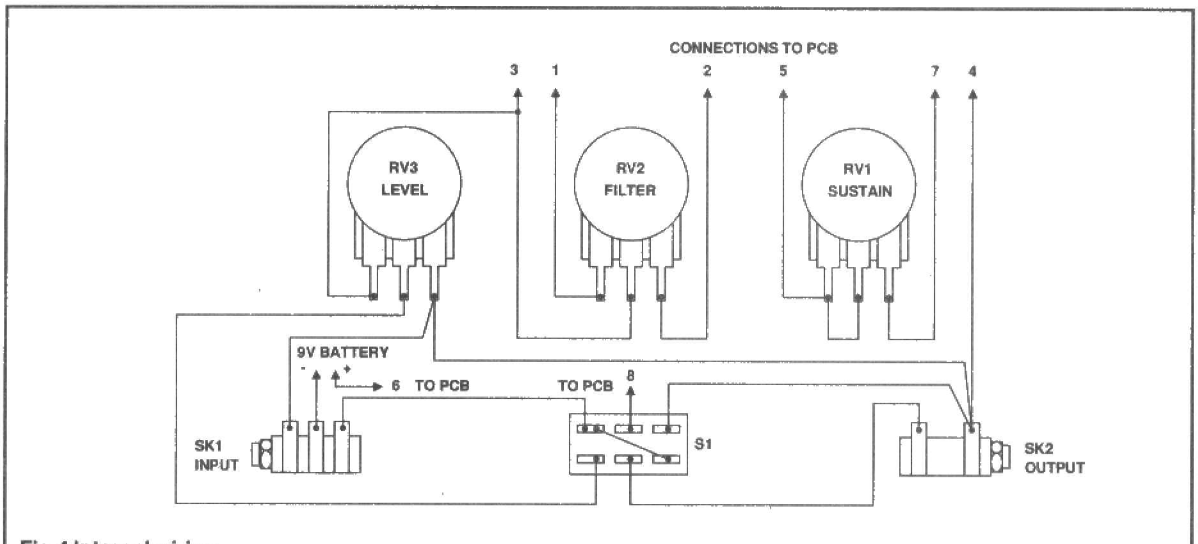


Fig.4 Internal wiring

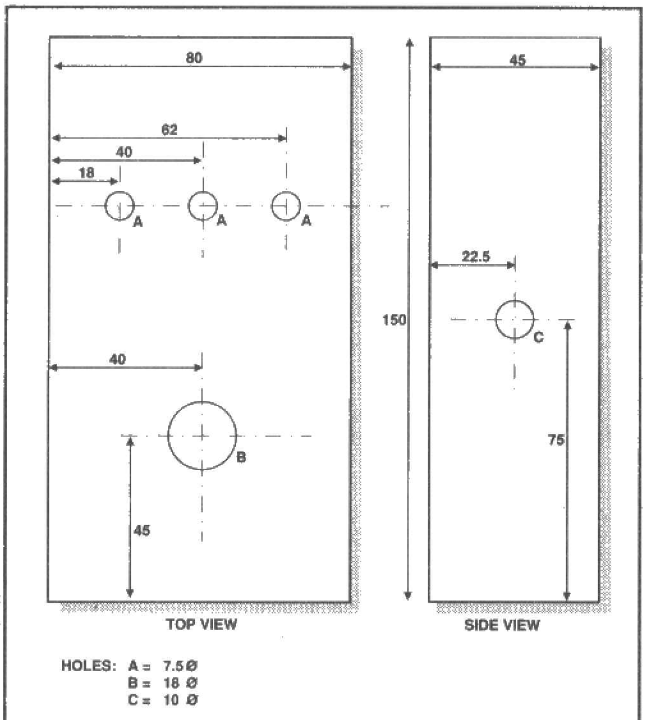
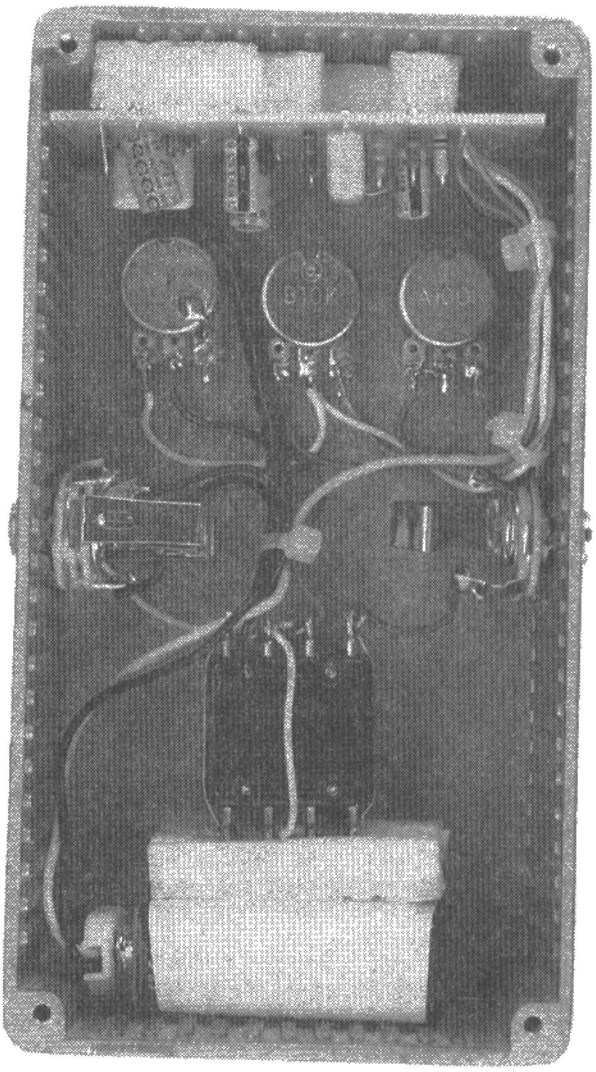


Fig.5 Drilling details

Connect all the flying leads to the PCB and use colour coding if possible, to avoid confusion. Leave them all approximately 6 inches long - these can be trimmed down as they are soldered to the various pots, switch and sockets once the case has been completed (see layout). Use screened lead for the input cable coming from the foot switch to the capacitor C2, earthing the screen at the PCB end only to avoid earth loops. If the jack sockets are of the moulded plastic variety, connect the earthy side of RV3 to its metal housing to earth the case.

Using the diecast case specified, mark out the holes with a centre punch (see drilling details) and drill 3mm pilot holes. These can then easily be drilled out to size as required. There is no reason why the unit could not be housed in a smaller case, but experience tells this author that miniaturisation is not necessarily an advantage, especially as he possesses size 12 feet!

The case can then be sprayed the colour of your choice - the prototype was sprayed a rather fetching metallic blue - and rub down lettering can be used to label the controls. Finally, give the finished case several generous coats of clear lacquer, to withstand the continuous stomping from your foot, and general abuse.



Testing And Use

When the wiring has been completed and checked, connect the battery in series with an ammeter. Plug a lead into the input and check that the total current flowing is around 300μA. If all is well, you are ready to test. If not, go back and check your wiring and component values. Check again the position of IC1.

With the input lead connected between the guitar and the unit, the battery will be switched on, therefore when the unit is not in use remember to unplug the input jack, to conserve battery life.

With all the controls positioned centrally, connect a second lead between the output jack and the input of your amplifier. According to how the switch is pressed, the guitar will either sound normal or distorted. Distorted sounds can be adjusted by setting the Sustain and Filter controls to taste (lower settings of the sustain control will give greater dynamics than it will when set fully clockwise). The relative level between distorted and 'straight' sounds can be adjusted with the Level control. Bear in mind that when in use, if you are too close to the loudspeaker of the amplifier, you will encounter mains hum. This is the inevitable result of the high gain circuit in a fuzzbox and will be more prevalent in guitars using single coil (non-humbucking) pickups.

If the unit doesn't work, double check all the wiring and component values and ensure that battery and component polarities are correct. Also, ensure that no wires or PCB tracks (other than the border track) are shorting against the metal casing.

Now go and make some noise - and remember, this device isn't limited to use by guitarists! You can distort just about anything with it if you wish.

PARTS LIST

RESISTORS
(all 1/4 watt 5%)

R1,2	33k
R3	560R
R4	100R
R5	390R
R6	8k2
R7	5k1
R8	1k5
R9	4k7
R10	100k
RV1	100k log mini pot.
RV2	10k lin mini pot.
RV3	10k log mini pot.

CAPACITORS

C1,7	47μ 16V PCB electrolytic
C2	47n polyester or ceramic
C3	3μ3 16V PCB electrolytic
C4	1n5 polystyrene
C5	1μ 16V PCB electrolytic
C6	100n polyester or ceramic

SEMICONDUCTORS

IC1	TLO61 JFET op-amp
D1,2,3,4	1N4148 silicon diodes

MISCELLANEOUS

SK1	stereo 1/4' jack socket
SK2	mono 1/4' jack socket
B1	9V battery type PP3 and clip
S1	DPDT heavy duty foot switch

DIECAST CASE
150 ∞80 ∞50 mm (bimbox number 5005); 3 knobs to suit RV1, 2, 3; Rub-down letters, spray,lacquer, wire, solder, screened lead, PCB.

BUYLINES

All parts are readily available, with the exception of the footswitch, pots and diecast case, all of which are supplied by MAPLIN. For a more robust footswitch, try your local music shops - Rhino products make a suitable type.

An electronic timelock providing limited amusement for the kids. Commentary by an unpopular Bob Noyes.

Pentacode

The kids come in from school, sling their bags down in the hall and swear blind they haven't got a scrap of homework to do. They tear upstairs and on goes the Nintendo or the TV. After some subtle or not so subtle questioning, you ascertain that there is a list of spellings to be learnt by one son and Science, Maths and French homework to be done by the other. You march into their rooms and turn off the TV/computer, then tell the kids in no uncertain terms that homework comes first and that there's no TV or anything else until it's done. By the time you've turned your back and got halfway through the door, the TV is on again with the volume turned down a bit and the homework takes twice as long to get done because of the distraction.

What was needed was some sort of electronic padlock that could be put on the TV and computer to stop them from being used at certain times.

A keyswitch was considered first, but was quickly discounted as keys disappear in our house almost as quickly as packets of crisps. Instead I came up with Pentacode, a system which has an up to five digit code that must be entered correctly for the TV/computer not be disabled by mains starvation. Each time a button is pressed the system bleeps indicating that a) a button has been pressed and contact has been made (essential on cheap keypads that have no tactile feedback) and b) that someone is attempting to enter a code or to find it by trial and error. When the five digits have been entered correctly, the output is used to switch a relay, the safest way to switch mains. However, if an incorrect button is pressed, the code is reset and will require the full code to be entered again from the beginning. Pentacode uses two standard ICs, which are very cheap and, if mounted in holders can be used again in a variety of projects if and when this particular one isn't needed anymore. The chips are 4013 double D type flip flops with independent clock.

Use 1

The original objective of Pentacode was to turn off a TV and games unit so a mains switch was required on the output. This can be done in one of two ways: an opto triac (solid state), or a relay. A relay was chosen as it is easy to see if a relay is energised or not and it is easier and cheaper for largish currents. The relay is mounted on the power supply board but great care must be taken with this, as the output contacts of the relay are at mains potential when wired and should be treated with the greatest of respect.

Relay PSU Board Description

This board was designed to work on either a straight AC supply of 12V or a centre tapped supply 12-0-12V. For straight 12V, all four diodes of the bridge are used with the

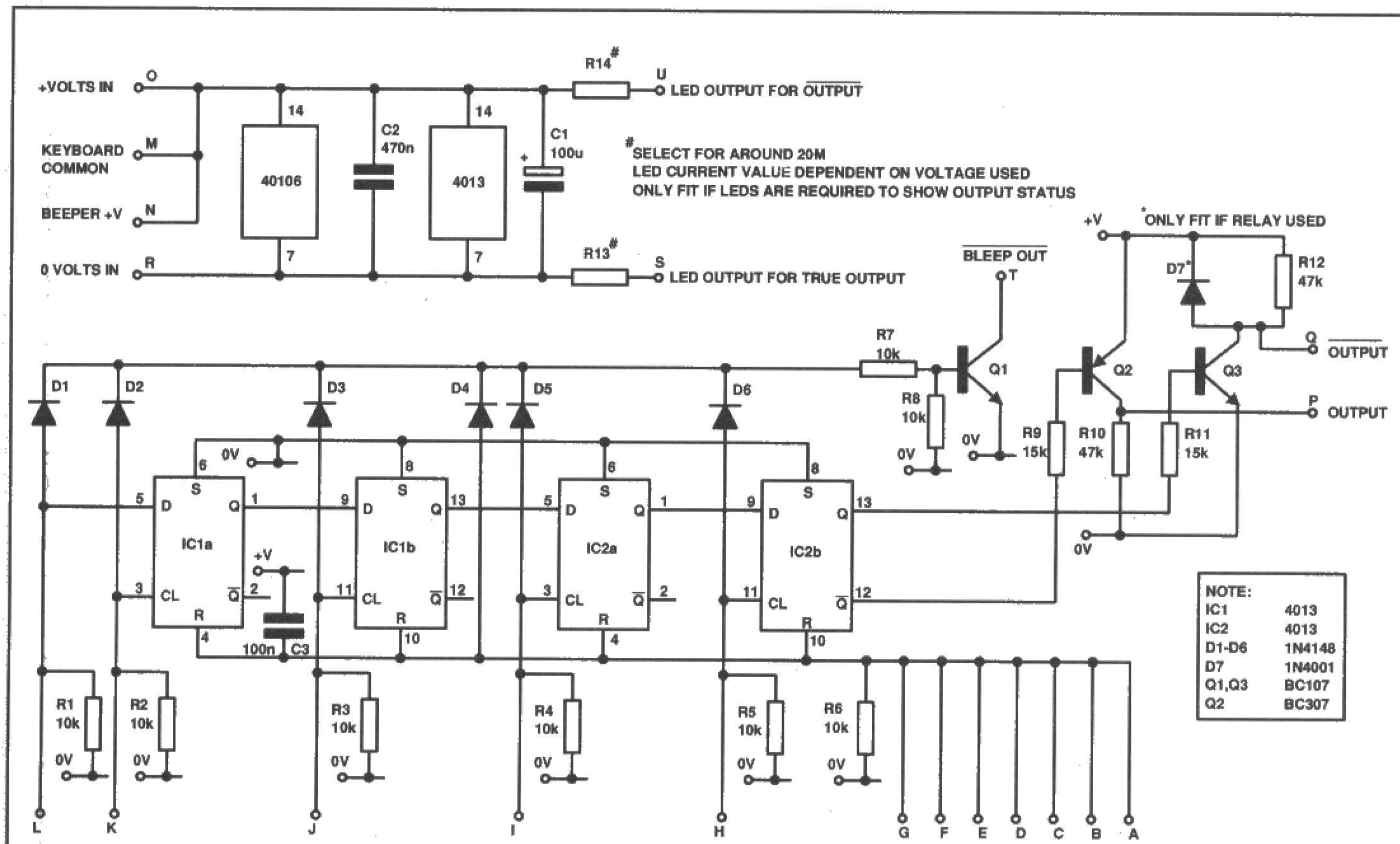


Fig. 1 Circuit diagram

12V AC going to pins 3 and 4. For an AC supply of 12-0-12V, Diodes D10, D11 are omitted. The two 12V inputs go to 3 and 4 and the centre tap goes to pin 5. Full wave rectification takes place and C4 smooths the pulsating DC into a relatively smooth 17V or so. IC3, the 12V regulator (7812) produces a stable 12V out to pins 11 and 12. C5 and C6 suppress any high speed oscillation and C7 ensures a low impedance output. All this is straightforward and this 12V is used to power the Pentacode board (pin 11 12V, pin 9 0V).

To make this a standard board, usable on other projects, the relay is not tied to either supply and both terminals are brought out - the positive to pin 7 and the negative to pin 8 (orientation required because of the protection diode D12). In this case, LK2 is required to connect the positive side to 12V. The relay now needs an active low on pin 8 to power it. This is provided by Q3 on the Pentacode board pin A. There is a protection diode on both boards; this is okay although the one on the Pentacode board may be removed (D7), keeping the closest one (D12).

The relay is a change-over type but only the common and N/O output function is required, so no connection is needed on pin 103. Pins 102 and 101 have male spade connectors soldered to the board - these provide a good safe mains connection to the relay. Insulated female spade connectors are used here to minimise the amount of mains exposed. These connectors provide the live connection to the mains output socket, which is an IEC type. If a normal 13 amp socket is used, the 13 amp plug can be removed and plugged in the normal mains socket. By using the IEC plug/socket there is nowhere else to plug it in (pretty sneaky).

Great care must be taken when mounting this relay board in the box: check the board is held well clear of the base - enough to allow for a nut, bolt or washer to freely pass under it if one should work loose in use. The ones used and recommended are 14mm long and M3 tapped. The wiring diagrams show the full circuit. The transformer used is a 12-0-12V type so D10 and D11 have been omitted.

WIRE LINK OR RESISTOR LIKE LINK

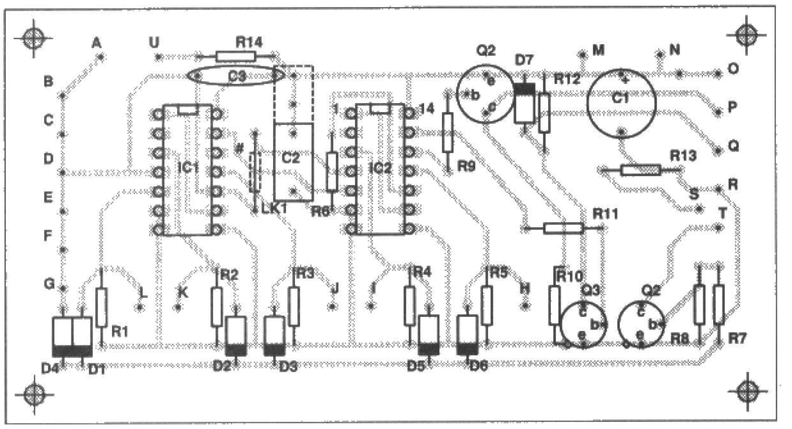


Fig.2 Component Overlay

Connecting Up

The transformer can be mounted in the box for safety and longish wires should take the secondary 12V AC onto the relay board. This allows the board to be worked on away from the mains, in safety, because at this stage there is no mains, as the output of the relay is left disconnected. While the

HOW IT WORKS

FIGURE 1

The principle of a D type flip flop is that the input on the 'D' is transferred to the 'Q' output on the rising edge of the clock pulse, but can be overriden by the set or reset which takes priority if used. This function is used to reset the whole combination if a wrong number is entered. The input stage of Pentacode is different from most code systems, achieved by bringing the D pin 5 and the clock pin 3 to the keypad via pins L and K respectively. These are normally held low by pull down resistors R1 and R2. In order to produce a high at the Q output pin 1, two buttons must be pressed. Firstly the D input must be made high and held high by holding down the button connected to it, while the clock is made high by pressing its button and releasing it before the D1 button is released. The sequence must be adhered to, to allow for 'switch bounce'. Switch bounce happens to all but the most expensive switches and, as the diagram shows, not only occurs when the switch is pressed but also upon releasing the switch.

FIGURE 3

To allow for the bounce on releasing the clock button, the D button is held down until the clock has been released, which ensures reliable operation.

From now on the remaining three digits can be entered normally as the following Ds are connected to the previous Q outputs and hence are not prone to switch bounce because the source is stable. Assuming the complete code has been entered correctly the output Q pin 13 of IC2 will go high, which will turn on Q3 via R11. If an incorrect number is pressed (not one of the numbers connected to pins A-G) the resets, which are all connected together, go high and the whole code circuit resets requiring the full code to be entered from the beginning.

All of the input pins have a path through diodes to the bleep line which is normally held low by R7 and RS. Q1 is turned on when any button is pressed. The collector is taken to a piezo buzzer to indicate that a button has been pressed.

As well as turning on a relay, there is a digitally compatible signal output pin P, which is normally low, held down by R10 and goes high when the correct combination is applied. This is done by using the a output pin 12 of IC2b, which is high before the correct combination is entered holding TR2 off, but goes low on completion of the correct combination. This low will turn on Q2 giving a high out of pin P. Care must be taken that the voltage running the board is the same as the voltage used in any following circuit connected to pin P or damage may result.

If a relay drive is not required, then D7 can be removed and the output pin Q is now a digital signal going low on completion of the correct code. Again the voltages should be the same for any subsequent electronics. If there is a voltage difference, either up or down, both D7 and R12 can be omitted - this then allows Q3 to be run as an 'open collector' and any voltage can be applied below 30V, while the current should be below 100mA, compatible with the output transistor Q3.

Normally only one of the outputs will be required, either a digital drive to another circuit, for instance as a standby control for alarms, or the relay output used for switching large loads. Two resistors have been provided, R14 and R13, which are to allow a LED to be used to indicate that the combination has been successfully entered. Either the active high transistor Q2 or the active low transistor Q3 can be used, normally the one not used for any following circuit or to drive the relay (see diagram). If batteries are being used, the LED can be omitted to prolong battery life. As can be seen from the circuit diagram, this is a very useful and, with its range of options, adaptable board.

buzzer should sound. Holding down switch (1) press switch (2), IC1 pin 3 should show 12V. Release switches (2) and then (1), now IC1 pin 1 should show 12V. When the next digit/switch is pressed, the corresponding stat should set: this happens for the following two stages. At any time, if one of the unused (in the code) digits/switches is pressed then the whole code must be started again as the unused ones are connected to pins A-G - the reset to all four stages.

Pressing any key passes a high through to the bleep line and turns on Q1 which in turn activates the buzzer connected between pin N (+12V) and T (active low). Assuming the Pentacode is working after the fifth digit/switch is pressed, Q3 turns on and energizes the relay, which should pull in. The 'set' LED connected between pins P (positive) and S (negative) should illuminate giving a visual indication that the relay is on. Pressing any digit/ switch not in the code should turn off the set LED and the relay should drop out.

When you are happy that all stages and functions are working, the boards can be mounted in the box. The temporary heatsink can

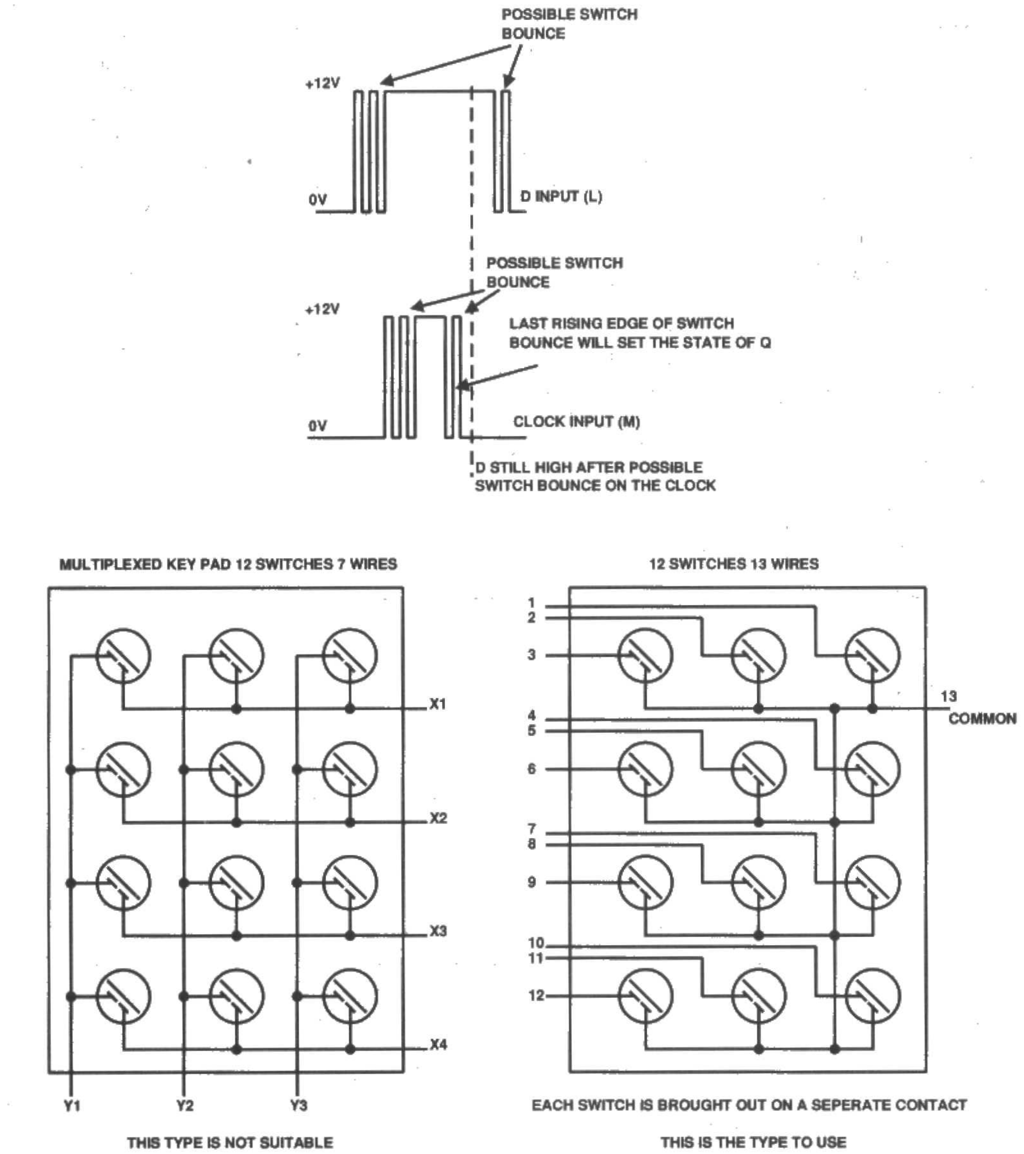


Fig.3 Switch bounce keyswitch diagram

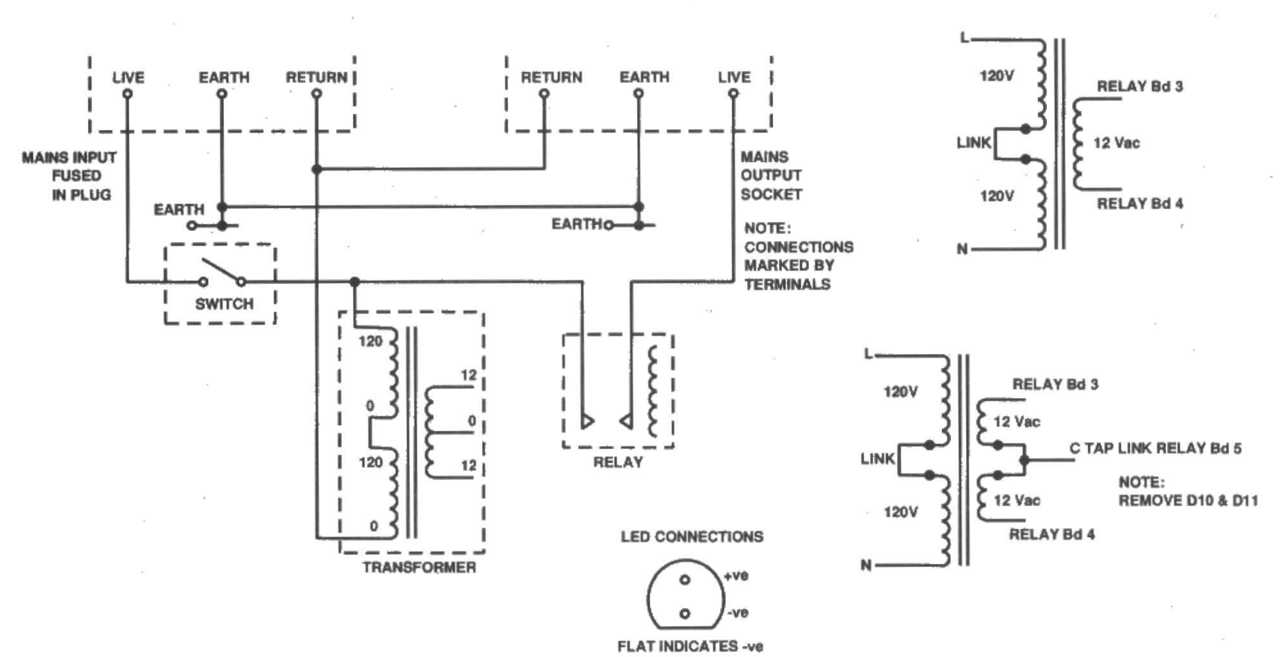


Fig.4 Mains transformer connections

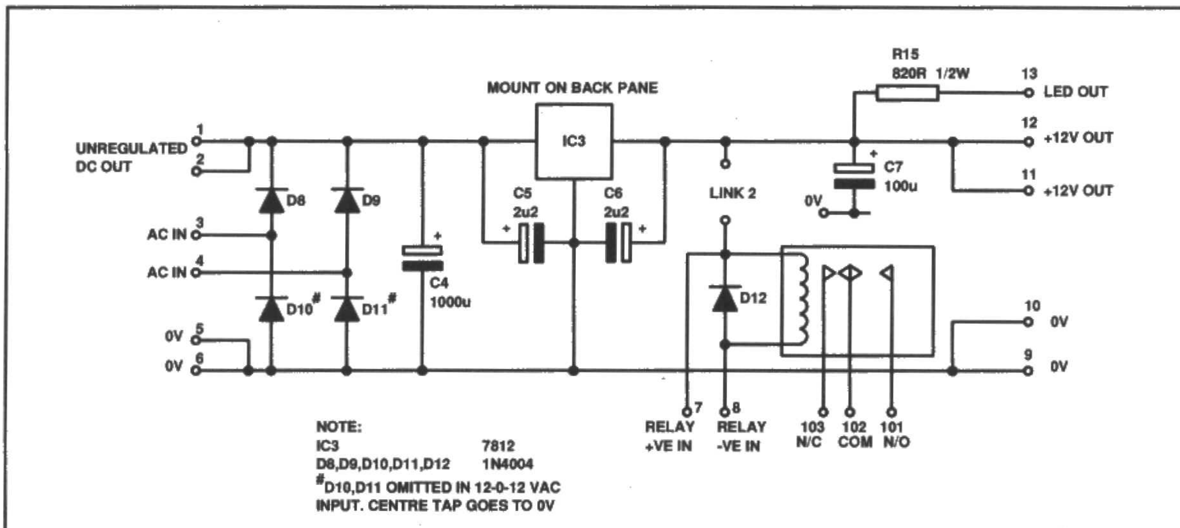


Fig.5 Relay board circuit

be removed from IC3 which should be bolted to the back panel. The transformer secondary wires must be shortened and the output of the relay connected - great care should be taken that the wiring is correct and that no wires have been allowed to separate and short out or even be exposed.

All the metal panels, front, back and base should be earthed with thick green/yellow wire (normal earth). Solder tags should be held down with crimped washers to prevent the bolts becoming loose. When everything has been mounted and connected, turn the unit upside down to check that nothing is loose and that no odd nuts or washers are hiding.

Remove the mains plug from the 13 amp socket and, with your meter, check between the earth pin of the 3-pin plug mains In. The earth pin of the IEC socket and the front and back panels should all show direct continuity on the lowest range of the meter set to resistance. Now check the mains in earth on the 3-pin plug, to both live and return. With the resistance range on the highest range there should be no path at all. Care should be taken not to touch the pins as body resistance will show up on this test. This should be done on the output IEC socket as well.

If all is well, connect a lamp or other low current device into the IEC socket and try it out. Enter the code and the lamp should illuminate - pressing any other switch should turn it off. When everything is working well, a larger fuse can be fitted to the mains plug but this should not exceed 5 Amps.

Several other uses have been found for Pentacode such turning off mains PA equipment at fetes and the like when they has to be left unattended for a while. I added a key switch to my unit, which turns on the relay by connecting pin 8 to pin 10 of the relay board. This still switches the mains via the relay as the key switch used can only handle 1 amp and we are switching 3 amps or so via the relay. It also reduces the amount of mains wiring because the key switch only switches 12V at under 0.1 Amp to the relay.

Stand Alone Use

Several alarm systems use a key switch to disable them. This is OK, but keys are easily lost. This board can be mounted normally in the original alarm box and can provide an active high, pin (P) or an active low, pin (Q). The supply to Pentacode is also taken from the alarm - this is to prevent spurious currents flowing between the boards an possibly causing damage. The wide range of voltages 5-18 makes the board ideal for such purposes. The LED supply resistors, R13 and R14 will need to be lowered if a voltage below 10V is used. The Piezo buzzer works well down to 9V or so. A lower voltage sounder will be needed below 8V.

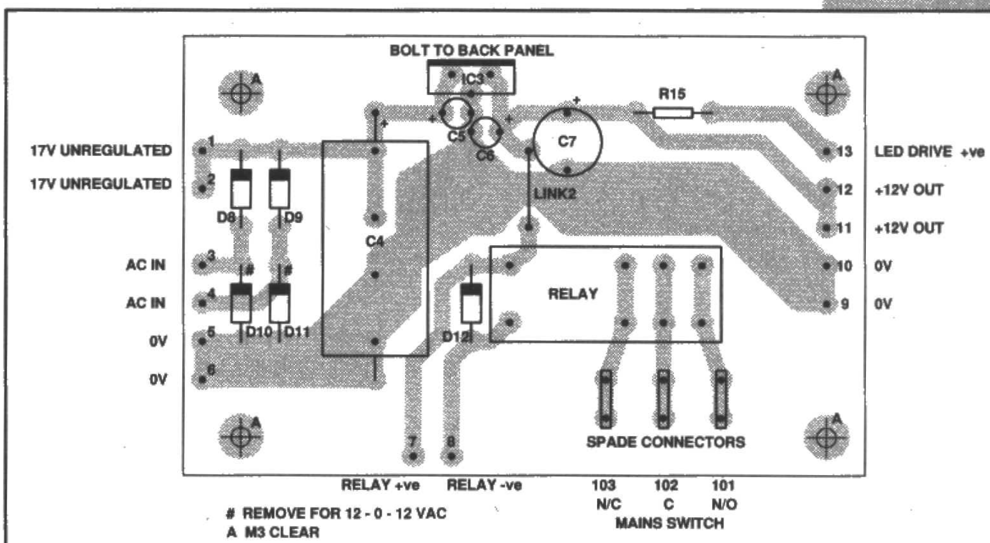


Fig.6 Relay board overlay

A neighbour has mounted Pentacode and relay board on a model train set. The AC supply is taken from that of the trains secondary and the relay switches the trains AC supply (15V AC) from the controllers when not required. This prevents the kids from playing with the layout when Dad (who's train set it really is) isn't around to oversee things. Because no mains is used in this set up, the boards are mounted in a smaller box, alongside the controllers.

PARTS LIST

RESISTORS
R1, 2, 3, 4, 5, 6, 7, 8 10k
R9,11 15k
R10,12 47k
R13,14 820R 1/2W

CAPACITORS
C1 100μ/16V
C2 470n/16V
C3 100n/16V Disc

SEMICONDUCTORS
Q1,3 BC107
Q2 BC307
IC1,2 4013
D1-6 1N4148
D7 1N4001

MISCELLANEOUS
Keyboard Electromail Cat no. 333-704 (must be 12 switches with common)
Buzzer 12V Piezo Maplin CR34M

RELAY BOARD

RESISTORS
R15 820R 1/2W

CAPACITORS
C4 1000μ/15V
C5 2μ/25V
C6 2μ2/25V
C7 100μ/25V

SEMICONDUCTORS
IC3 7812
D8-12 1N4004

MISCELLANEOUS
Relay 12V coil at least 10A contacts
Transformer 6VA 12-0-12V secondary
Spade connectors,suitable box, mains socket and plug,mains switch
Keyswitch Only if permanent override required
2 x panel mounted LEDs 1 red 1 green

Moving Coil Meters

Ray Marston continues his in-depth look at modern electronic analogue V, I, and R meter circuitry.

The opening part of this mini-series, in March, looked at DC metering circuits and at transistor-based AC meters. This month we continue the AC theme by looking at op-amp based AC meters and at precision AC/DC voltage converter circuits.

Op-Amp AC Meter Circuits

The general AC-metering principles outlined last month can be applied to any type of amplifier device, including op-amps and Figure 23 shows a type-741 op-amp used as a direct equivalent of the Figure 6.19 transistor circuit, with the meter network wired directly between the op-amp's output and its inverting input. This circuit gives excellent linearity, but its frequency response is severely limited (to 37kHz at -1dB) by the op-amp's slew rate limitations and this design offers no real advantage over the simple circuit of Figure 6.19.

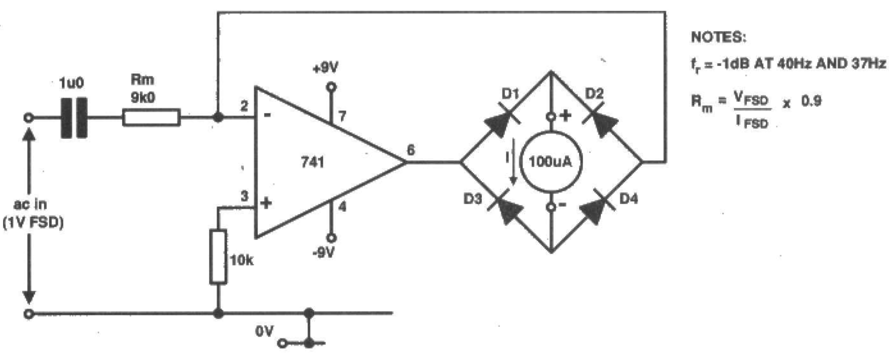


Fig.23 Simple op-amp 1 volt ac meter circuit.

Figure 24 shows an improved version of the above design. In this case the meter network is wired between the op-amp's output and ground via Rm (which sets the meter's basic FSD. sensitivity at 1V), and the rectifier network is linearized by feeding Rm's output voltage back to the inverting input terminal via the R1-R2 network, which sets the circuit's overall (input-to-Rm) gain at unity. With the component values shown, the circuit thus has an FSD sensitivity of 1V; although the circuit's input impedance (100k) is determined by R2 and is independent of the meter's value and the meter does not have to be a particularly sensitive type. In the Figure 24 design, R3 is used to give the meter overload protection, and (in conjunction with Rm) limits its peak current to about treble the FSD value. This protection is gained at the expense of reduced bandwidth, which is typically about 15kHz at the upper -1dB point when using a 741 op-amp (the bandwidth can easily be extended by a factor of ten, to about 150kHz, by using a 'fast' op-amp such as a 3140). The effective FSD sensitivity of this circuit can be increased to 100mV by

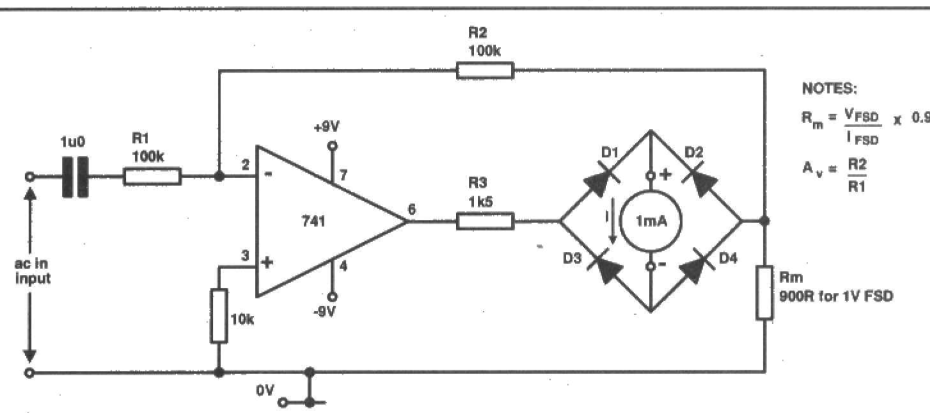
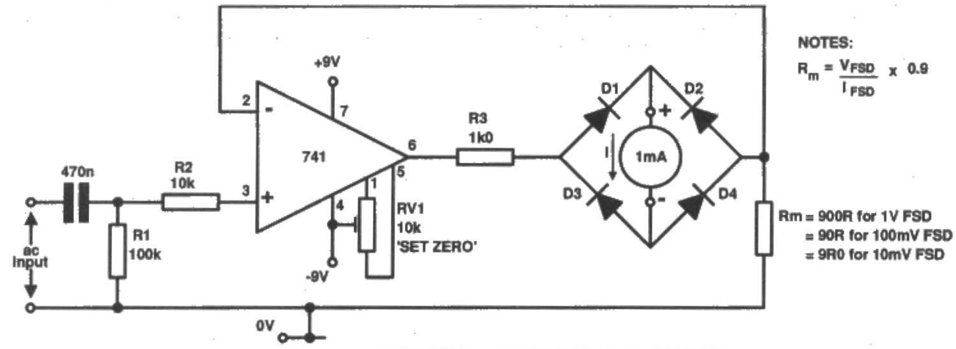


Fig.24. The input impedance of this circuit is independent of meter sensitivity.



FSD VALUE	f_T AT FSD -1dB	f_T AT FSD -3dB	f_T AT 10% OF FSD -1dB	f_T AT 10% OF FSD -3dB
1V0	15.5kHz	23kHz	15kHz	32kHz
1V0*	27kHz	36kHz	40kHz	85kHz
100mV	10kHz	17kHz	1.5kHz	4kHz
10mV	1kHz	2.2kHz	40kHz	270Hz

* PERFORMANCE WITH R3 S/C

Fig.25 This ac voltmeter offers a high input impedance.

reducing the R1 value to 10k (to give an overall gain of x10, or 20dB), but in this case the bandwidth falls to only 6kHz at the upper -1dB point.

Figure 25 shows an AC voltmeter circuit that is a great improvement over the previous two types. The meter network is again wired between the op-amp output and ground via Rm, which thus sets the meter's basis FSD sensitivity, but in this case the circuit is wired as a unity-gain, non-inverting amplifier or voltage follower and gives an input impedance equal to the R1 value. The op-amp is provided with input overload protection via R2 and with meter overload protection via R3. When wired as a 1V meter, the circuit's bandwidth reaches 15.5kHz at the upper -1dB point if the meter protection facility is used, but extends to 27kHz if R3 is shorted out.

This circuit's sensitivity can be increased by reducing the Rm value, at the expense of reduced bandwidth, as indicated in the table, which lists the circuit's performance details both at FSD and at 10% of FSD. Thus, at 10mV sensitivity, the upper -1dB point occurs at 1kHz at FSD and at 40Hz at 10% of FSD. This abysmal performance is attributable to the inherent limitations of the 741 op-amp.

Op-Amp Limitations

The performance of the Figure 25 circuit is actually limited by the op-amp's output slew rate and f_T or 'gain/bandwidth' characteristics. The 741 op-amp's slew rate limit is about 0 5V/µS and its f_T value is 1MHz. Figure 26 shows the 741's typical 'small signal' output characteristics. Its maximum voltage gain is 105dB, but is frequency dependant and falls off at a 20dB/decade rate, equaling unity at 1 MHz.

Returning to Figure 25, note the following points from the measured performance data:

1. When the meter is scaled to read 1V FSD with R3 shorted out, the FSD performance is limited mainly by the op-amp's slew rate and is 1dB (about 10%) down at 27kHz and 3dB down at 36kHz; it's 1/10th of FSD 'linearity' performance is limited mainly by the op-amp's f_T characteristics, and falls by 3dB at 85kHz as the available 'linearizing' gain falls to about 20dB.

2. When the meter is scaled to read 1V FSD. with R3 in place, the slew rate limitations increase and effect the '1/10th of FSD readings'; the -3dB points then occur at 23kHz at FSD at 32kHz 1/10th of FSD.

3. When the meter is scaled to read 100mV FSD, the sensitivity is increased by 20dB and available bandwidths reduced by a combination of slew rate and f_T limitations; the -3dB points occur at 17kHz at FSD, 4kHz at 1/10th of FSD.

4. When the meter is scaled to read 10mV FSD the basic sensitivity is increased by a further 20dB and the available bandwidths are reduced by a proportionate amount; the -3dB points occur at 2.2kHz at FSD and at 270Hz at 1/10th of FSD.

The important thing to note from the above data is the point already made in last month's 'AC Voltmeter Basics' section, namely that the op-amp gain factor needed to give 1% linearity = $100/V_{FSD}$ that is +40dB at 1V FSD, +60dB at 100mV, and +80dB at 10mV. Linearity and FSD accuracy start to decline when the available gain falls below the required 'critical' value. Thus, on the 10mV range, the 741's open-loop gain starts to fall below the critical +80dB level at about 100Hz and the meter's low-level linearity starts to decline as the gain falls below this value. It is 3dB down at 270Hz and the FSD precision starts to collapse after a further decline of about 20dB (and is 3dB down at 2.2kHz in this example). Thus, a combination of wide bandwidth and high FSD sensitivity can only be obtained by using a 'fast' op-amp, or by cascading a number of op-amps to give the desired gain-bandwidth product.

TO BE CONTINUED

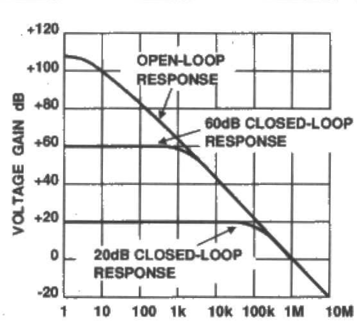


Fig.26 Typical 'small signal' response curve of the 741 op-amp.

Radio Control Trafficators

In the start of a mini-series, Craig Talbot describes some useful extras for your model control.

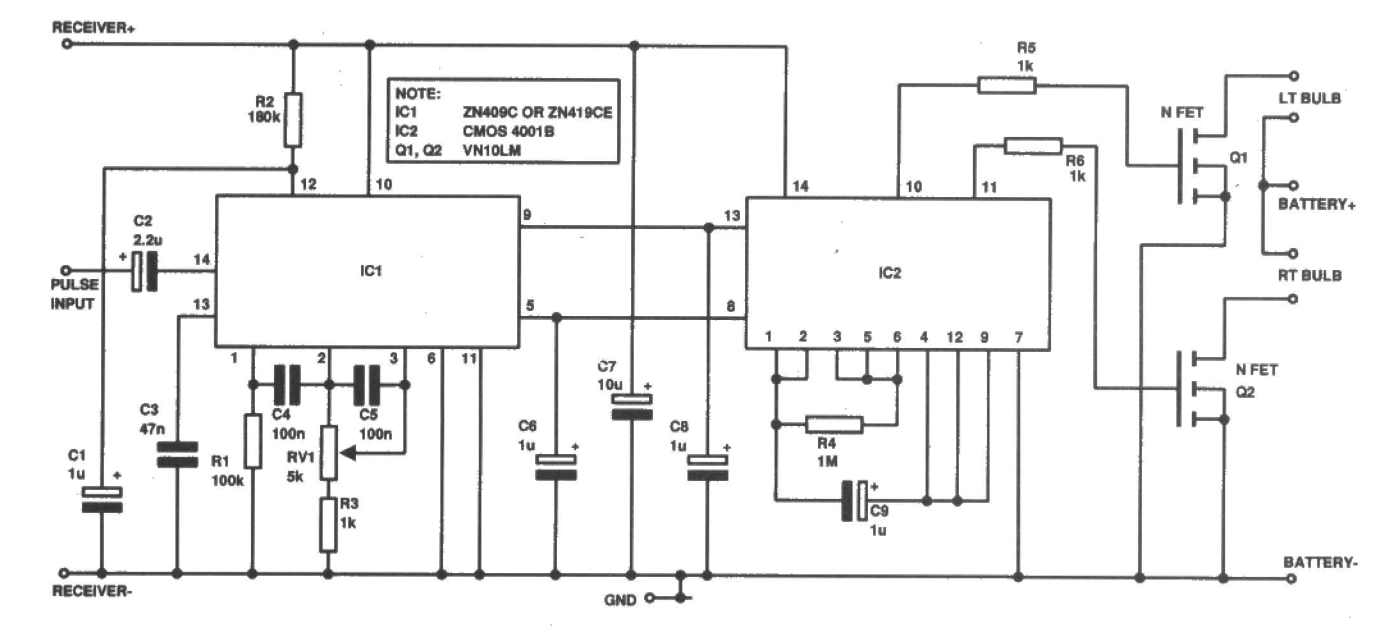


Fig.1 Circuit of radio-controlled trafficator

PROJECT

Radio control transmitters, receivers and servos, which are normally referred to as the outfit, are available at prices that make home construction appear very expensive. The Transmitter must comply with the regulatory bodies in terms of the band width and purity of the transmission. The Receiver must have a very high performance, in comparison to broadcast band receivers, as it will have to give totally reliable performance when placed either right next to a transmitter or half a mile away from it. It will also need to have excellent rejection of transmitters just a few tens of kHz away from its frequency. The Servo, the muscle of the outfit, with its precision motor and gearbox, not to mention the electronics, represents remarkable value for money at its present market price and would be almost impossible to build without buying the greater part of it.

For all these reasons, the Electronics enthusiast's best contribution to his outfit would be in the area of Add-On projects, concentrating on doing the jobs that the basic outfit does not do well, like switching on and off lights, sounds, speed Control of drive motors and so forth.

Direction Indicators (Flashers)

This project is an add-on circuit for any Digital Proportional radio controlled model which requires direction indicators. The Radio Control equipment must be the type which gives an output of 1ms to 2ms positive signal from the decoder. This is far and away the most common type of output - in fact it is probably the closest to a universal standard that I know of, in any field. Both AM and FM outfits use the same standard.

Digital Proportional Radio Control

A few words about the method used in the so called Digital Proportional type of control system will explain

How It Works

The circuit uses a Servo control IC, ZN409CE (ZN419CE is basically the same) and a CMOS 4001, both of which are readily available in the UK. The 409 is an IC which I find very useful as it gives the normal complementary outputs and, in addition, a direction output which is handy for switch functions and forward reverse speed controllers. In this application however, only the complementary outputs are used to drive the right and left signals which are in turn ANDed (the LOGIC term) with the flasher oscillator to drive the output powerfet switches.

As can be seen in the circuit diagram (Figure 1), the input from the selected receiver channel is fed via C2 to remove the DC voltage at the output of the decoder. The input circuit of the IC1 is triggered by the leading edge of the pulse and starts a monostable timer, the timing of which is set up by RV1 together with R3, R1 and C4 at 1.5ms (neutral).

C5 is to decouple any RF from entering the circuit from a transmitter in close proximity. The outputs at pins 5 and 9 will give a stretched version of the positive or negative error between the input and the 1.5ms monostable.

R2 together with C1 stretch the output pulses on pins 9 and 5 so that the lights do not flicker between successive frames of information from the receiver which you may remember is 20ms. Unfortunately I was unable to stretch the pulses long enough with this method as the IC was designed to drive a motor which will continue to run between frames, even if the drive is only pulsed. To this end C6 and C8 were added and this overcomes the problem.

C3 is a dead space capacitor to ensure that around the neutral position nothing at all will be output from pins 5 or 9. For anyone who has used this IC it will probably seem quite a high value, but the reason for this is very simple. When using a two axis stick to drive this circuit, it is not easy to move the stick up and down without some straying left or right in the process. Just a small movement would trigger the flashers if the dead space was too small, hence the high value of C5.

Two gates of the 4001 together with R4 and C9 produce a standard CMOS oscillator which pulses at about 1 to 2 pulses a second, about right for flashers (the best advice I could get was that they should pulse between 60 and 120 pulses a minute). This is ANDed with the left or right outputs of the 419 which in turn drive the two output devices. The powerfets Q1 and T2 are fed by R5 and R6 which limit the current into the gate of each device.

Although these are field effect transistors the gate capacitance can be quite large and charging this can cause high current to flow into the gate. This may result in damage, so it is good practice to limit this current although in this design the CMOS driving it probably wouldn't cause any problems. Still, better safe than sorry.

the terminology used in this project and give a better understanding of how the circuit functions. I say so called, because the latest state-of-the-art Radio gear uses Microprocessors and is truly digital, whereas the Digital Proportional type could better be described as pulse position multiplex or PPM.

Information about what the operator wishes to have happen at the receiver is sent by the transmitter in frames of pulses. These frames are normally around 20 milliseconds long, normally written as 20ms (0.02s). A frame contains a series of pulses, the number of which depends on the number of channels. A six channel outfit, for instance, will transmit seven short pulses. The time from the leading edge of the first pulse to the leading edge of the second will be decoded as the required position of channel 1. This will be a value between 1ms and 2ms with 1.5ms as a centre or neutral value. Channel 2 will be from the second to the third pulse and so on until the seventh, then back to the first which is the reset period. A little bit of basic arithmetic will show that 6 (channels) times a maximum of 2ms equals 12ms, which leaves 8ms reset. It is a simple matter for the receiver decode circuit to discriminate between a proper channel and a reset pulse and so

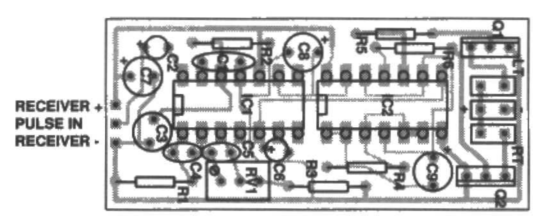


Fig.2 Component overlay

perform a reset to ensure that the decoder faithfully follows the encoder in the transmitter.

If we move a stick from its centre position we are in fact moving that channel from 1.5ms (neutral) towards either 1ms or 2ms depending on the direction that the stick is moved. The output of the decoder will follow this and produce an output for each channel. The decoder is in fact a simple shift register with reset.

All of this happens quite quickly in human terms, the frames are updated fifty times a second and even a long channel pulse is only one five hundredth of a second.

In electronic terms however, this is slow, as modern circuits do the business at tens or even hundreds of millionths of a second, so we will be working far from the frontiers of high speed circuits. This slow speed makes life easy, as the layout of the circuit is by no means critical, allowing the circuit to be built on Veroboard and similar board materials. This construction project is based on a printed circuit layout for the compact nature and physical strength that this form allows, not because it is the only way.

easily be left until last, which is handy because these are the ones we need to take special care with.

Watch out for the polarity of the tantalum capacitors, which are clearly marked on the layout diagram. Most tantalums appear to be marked with positive, but if you come across one that is not, I have found that the positive is the pin to the right of the markings as you read them.

The input lead should be connected as per the layout with + (positive), in (input) and - (negative). This is a lead to match the radio control outfit that you are using which is probably coloured red white and black. Naturally enough red is +, black is -, and white is the input to our circuit from the receiver.

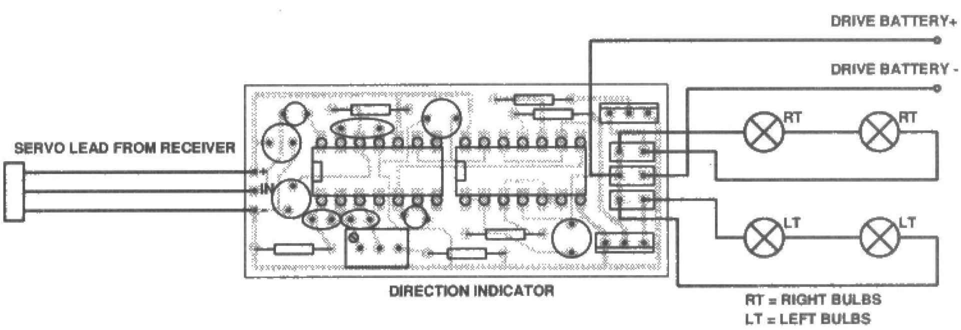


Fig.3 External wiring

Background

The normal method of driving the indicators is to use the steering to operate switches which in turn drive some kind of flasher circuit. This method ensures that you will only indicate after the vehicle has started to perform the turn (I am aware that some drivers do this, but this is not what should happen). To be like the real thing, a spare channel should be used for this task, thus enabling a signal before a turn. As far as I was aware no such device could be purchased, so I set about designing one.

The unit was to be simple to ensure a low component count and hence a low component cost. The finished unit should of course be small, in order that it could be used on smallish models. It should also be easy to build.

Due to these requirements, a Printed Circuit Board (PCB) was the obvious construction method to keep the size down. The unit should also be able to drive bulbs of a reasonably wide wattage range so that the same circuit can be used whenever this function is required on a model of any size.

The prototype has been run for over a year and I have constructed several examples of the circuit. At least three versions were built to improve the board layout, and make it reasonably compact.

Construction

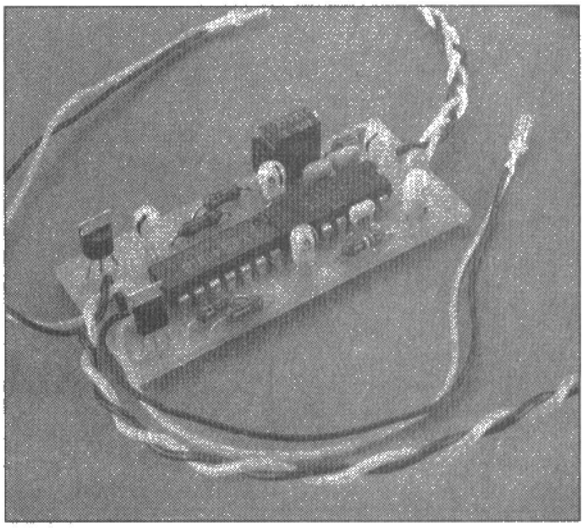
As IC2 (4001), Q1 & Q2 are all FET devices, care should be taken in handling them as they are sensitive to damage by static charges. Observe the normal handling precautions with these devices.

This is a very simple radio control circuit to construct as the components are not very tightly packed and small in number (see Figure 2 Layout). No particular order of placement is required, although I do find that fitting the components along one side and then working my way across the board is as good a method as any.

IC1 will have to be fitted when you can still easily get it located, but, as the board has a very low profile at the end where IC2, (CMOS) FET1 and FET2 are fitted, these can

On the layout diagram (Figure 2) you will see a triple box at the right hand side. This is for the connections to the flasher bulbs and the drive battery. The box marked LT should have a pair of twisted wires to the Left Trafficator lamps, same again for the RT box (Right Trafficator lamps). Figure 3 should help here.

The two connections in the centre box are the + and - connections to the drive battery. I say the drive battery because most Radio Control vehicles and boats have a battery for the Radio and another for power to the drive motor. At this point you will need to know the voltage of the drive battery in order to select the correct lamps for the job. As you will require two lamps for front and rear Left and two for front and rear Right, you will have to decide which is the best way to wire them, either in series or parallel. The voltage of the battery and available lamps will determine this. In my case it was very easy as, since my drive voltage was 12V and 6V



PROJECT

lamps were readily obtainable, I wired in series.

A visit to your local model shop will enable you to purchase both the lamps and the input lead. The output transistors will handle currents up to half an amp so this should prove adequate for the largest of modellers bulbs. Torch bulbs could also be used, although these tend to be a bit on the large size. Many drive batteries are 8.6V nicads and these will require 9V bulbs wired in parallel. Of course LEDs can be used (with a suitable current limiting resistor) but they will need to be Hi- Brightness types as normal LEDs will be difficult to see in sunlight.

That is about all I can say on the construction except make sure your do a check of all the under board soldering. There must be no solder bridges between tracks and all the components should been cropped off close to the board. Also check for good solder joints, as it is no exaggeration to say that most construction projects that don't work first time are due to badly soldered joints. Bear in mind the vibration your model will probably undergo during its life.

Testing

Clear the bench of all the construction clutter, so we can test the circuit. Imagine how annoyed you would be if a stray bit of wire blew up your new circuit!

As with the construction, the testing is almost too easy. Get out your Transmitter and receiver and make sure the batteries are good, or charged, whichever the case may be.

Connect the input lead of the circuit to your receiver and switch on the transmitter then receiver, in that order.

You will probably have a pair of bulbs flashing at this point. The object is to adjust RV1 to the off position with your selected channel stick at centre (and stick adjuster at centre).

As the adjustment pot on the board is a twenty turn device and we don't know where it is set, you will have to wind it clockwise and anti-clockwise until you find the neutral position. When you have done this you can then move the transmitter stick in each direction to test that the lamps stop flashing when the stick is in the centre position.

RV1 may need a little tweak to ensure that it is set in the middle of the dead space so that small drifts in the radio gear will not cause sporadic flashes when you don't want them. When you are happy with the adjustment you can apply a spot of paint (or nail varnish) to the preset to stop any movement of the adjustment screw due to vibration. That's all the testing and calibration it requires.

You may find, as I do, that heat-shrink tubing is a good encapsulation for model electronics, or a small plastic box - it really depends on the model and where it has to be fitted. On the subject of plastic boxes, small potting boxes can be useful for very small boards. They are available in a large range of sizes but it's not usually possible to find a plastic box exactly the right size, which is why I normally use heat-shrink. Clear is the best type to use so that it is easy to find the adjuster and cut a small hole.

That is just about it, and I hope you find the project a useful addition to your Radio Control Equipment.

PARTS LIST

RESISTORS are quoted as 1/8 Watt minimum, but the 0.6 Watt will do.

R1 100k
R2 180k
R3 1k
R4 1M
R5 1k
R6 1k
RV1 5k LIN 20turn 5/8" square (0.1" lead spacing)
In line pins - miniature preset potentiometer.

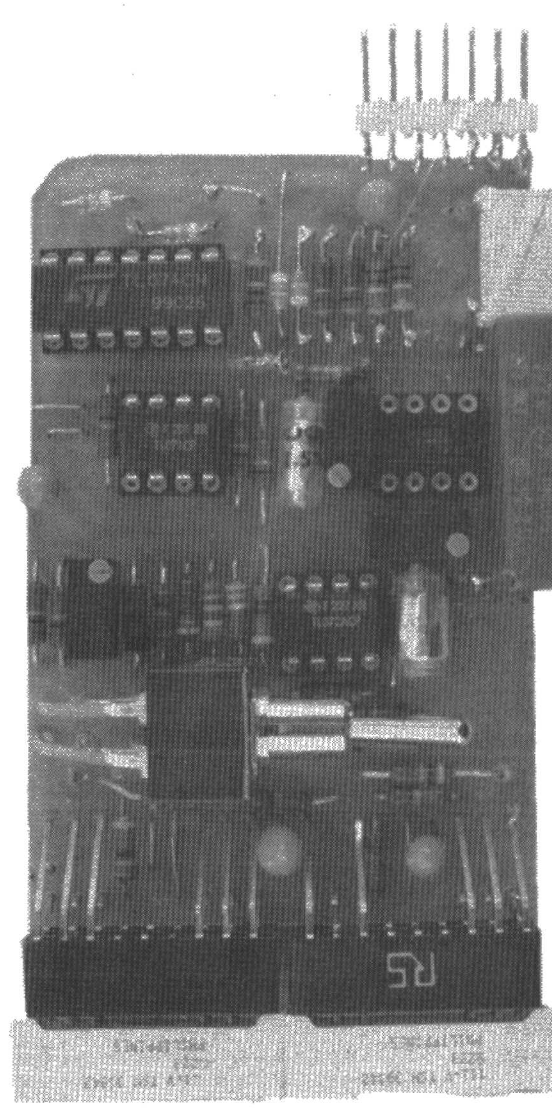
CAPACITORS

C1,6,8,9 1µ/10V tantulum bead
C2 2.2µ/10V tantulum bead
C3 47n ceramic (473K)
C4,5 100n ceramic (104K)
C7 10µ/10V electrolytic

SEMICONDUCTORS

Q1 V10LM POWERFET (handle with care - MOS)
Q2 V10LM POWERFET (handle with care - MOS)
IC1 ZN409CE or ZN419CE IC
IC2 CMOS 4001B IC (handle with care - MOS)
PCB see PCB layout
Lamps These will have to be selected for the supply. See construction notes.
Input Input lead (servo lead/connector) available from model shops to suit your radio gear.
Wire Red/White/Black or any other colour you prefer (length to your requirements)

The final instalment of the Peak Programme Meter project by Mike Meechan



Decide at this point if you want to experiment with both types of ballistic response. This is important, because if you do wish to experiment with the ballistic response, all of the components marked with an asterisk on the overlay must not be soldered directly to the PCB, but to Veropins soldered into the relevant holes. Why do this? The board/tracks will only tolerate about one soldering/desoldering operation after which they decide to part company on less than amicable terms. Using pins, however, means that components can be soldered and unsoldered as many times as necessary (when converting from VU to PPM or vice versa), with no detrimental effect to the trackwork. If you are intending to cascade boards, both types of respones can be accomodated using the two PCB's.

Resistors and diodes come next (ensuring correct orientation of the polarity-conscious components) and then the smaller capacitors. It is important that IC sockets are used. The op-amps, while not particularly expensive, are FET input types and require appropriate handling precautions. Fit the PCB connector next. If the constructor opts for the hard-wired approach, all flying leads should be soldered to Veropins and *not* directly to the board.

Choice of capacitor type, for the main time constant-determining component, was wide. Capacitance values of this order normally dictate electrolytics. Tolerances on these range from +/-20% for some to -50% to +100% for others. If

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you have a capacitance meter to hand, use it to select the most accurately valued one from a batch of 10 or so. Commercial designs use electrolytics, with the discharging resistor adjustable on test (AOT). Aside from requiring a PPM dynamics test apparatus, there is no single resistor which can be trimmed, since altering the value of the discharge resistor in our example (R805) would necessiate changing four other, non-equal resistors (R801 to 804).

Polyester layer capacitors are available in values up to 2u2. These are smaller than other polyester types and will fit on the board. If you can live with a release time constant which falls a little short of the specified one, this is an easy, repeatable option. 3u3 and 4u7 values are obtainable in larger, polyester or polycarbonate packages and their bulk limits how close adjacent boards can be fitted. Another option is the solid electrolyte tantalum type. This is small in stature but big in capacitance and with a tolerance rating identical to the polyester types. The board can accomodate all types. The Table in Figure 12 gives associated resistor values for various sizes of capacitors. The polyester layer capacitor is one of two components on the board which must be *purchased from the suppliers specified. This is because the* PCB layout has been arranged to suit exclusively these components and others, while perhaps offering the same performance, will not fit physically onto the board. Apart from the polyester layer, electrolytic or tantalum types, others must have their mounting pins bent through 90 and soldered to Veropins. The alternative mounting position for this type of capacitor is shown dashed on the component overlay.

If the budget version is constructed, the discrete transistors should be soldered onto the board at this point, with each transistor in as close as possible in contact with its neighbour. This ensures good thermal tracking and temperature drift compensation in the log amplifier. I've specified E-line types, since each of these can be abutted to its neighbour with the minimum of fuss. Mount the other capacitors with particular regard to orientation for the polarity-conscious ones and conclude with the previously mentioned C802. Decide at this point if you wish to cascade two or more boards. The lower-most board of each section should be constructed as per overlay 1 in Figure 8. Others follow overlay 2, which is shown in Figure 9. If you do wish to cascade boards, one of the specified capacitors must be used, *since other types overhang the edge and don't allow adjacent*

boards to butt together. Next are the cermet multiturn presets. I have specified types with the actuating screw mounted on the side of the body. Follow the diagrams closely with regard to correct orientation - with the screws positioned as they are, in-situ adjustments are possible. A case in point might be the meter bridge of the AutoMate. If you wish to save some money, normal ones can be substituted for PR802 and PR803, although line-up becomes a little difficult. Do not replace PR801 with a normal type as nulling the op-amp with an ordinary pot is well nigh impossible.

The penultimate part to be soldered onto the board is the switch (if required). It allows selection of either 'bar' or 'dot' mode and so may be mounted off the PCB. Should you wish to set mode of operation via the PCB switch only , the specified switch type *must* be used since no others will fit onto the PCB. Where the switch is omitted entirely, wire links soldered to Veropins should provide the necessary hard-wired module configuration.

The PCB will normally be mounted at right-angles, so the bargraph modules must be mounted on right-angled sockets. The last, most awkward operation, is the fitting of DIL sockets and great care

y Mixer

must be taken when bending the wirewrap pins to the required shape. Figure 11 gives the recommended bending point on the legs. Each set of three legs must be bent simultaneously using a pair of fine taper-nosed pliers. Crop all of the unwanted legs, thus making the bending easier and the remaining legs less prone to fracturing. A useful aid when working out where to bend the leads is a strip of thin tape placed along the surface - PCB track layout tape is ideal.

Testing and Setting Up

To set up the unit accurately, a tone source with variable output level control is required, as well as a high impedance voltmeter, 'scope or digital multimeter. For those not fortunate enough to possess the tone source item, I have included a circuit (Figure 13) which will generate

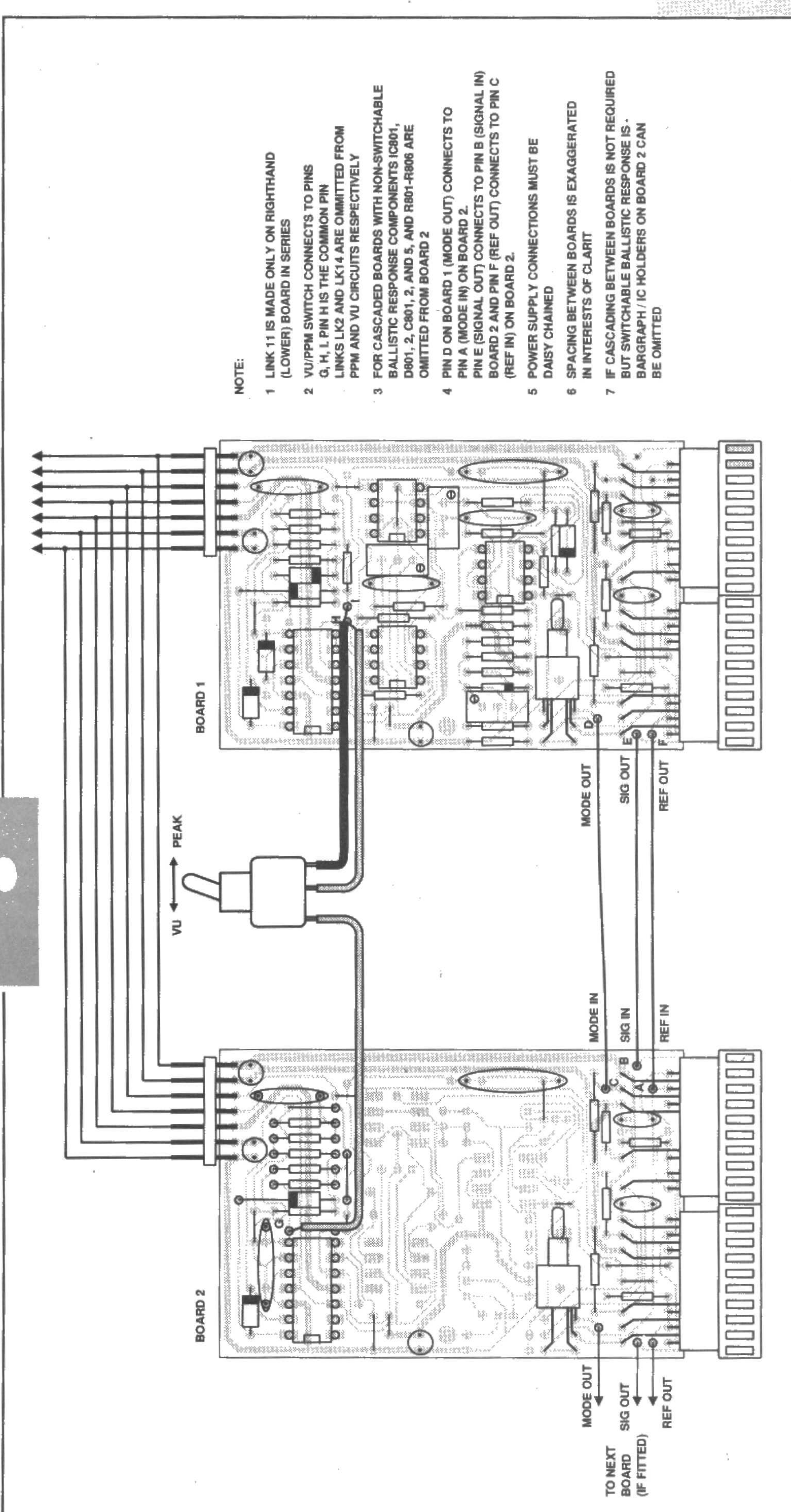
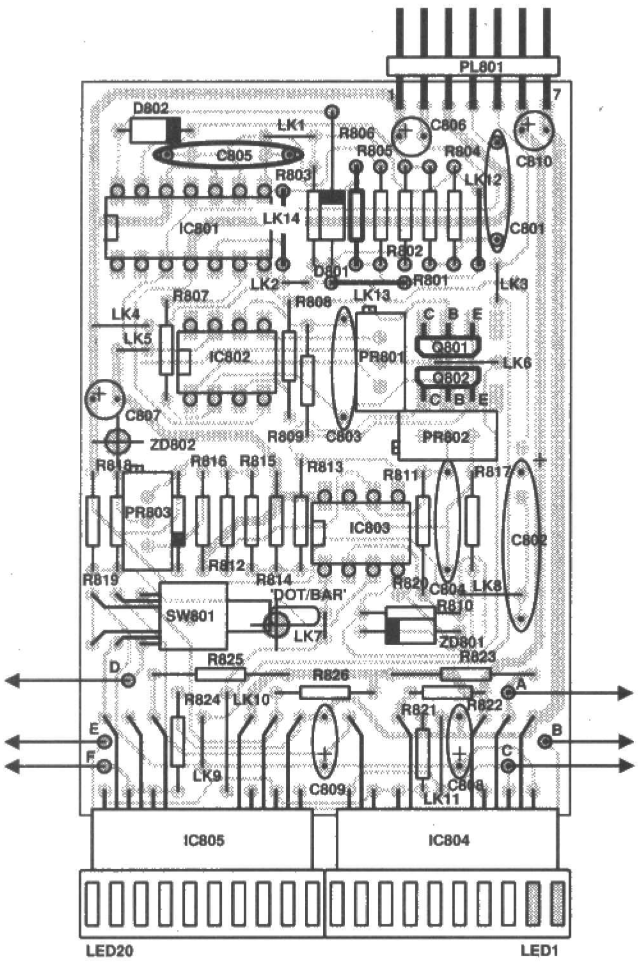


Fig.9 Cascading boards



COMPONENT OVERLAY FOR VU OPTION. SHOWN IS SECTION WHERE COMPONENT VALUES OR PLACEMENTS ARE DIFFERENT FROM PPM VERSION. PARTS NOT SHOWN ARE IDENTICAL TO PPM OVERLAY. VEROPINS (OR COMPONENTS SOLDERED TO VEROPINS) ARE SHOWN THUS ◎ OR ◎—◎
ALSO SHOWN IS IC806 (SSM2210 SUPER-MATCHED PAIR) REPLACED BY DISCRETE TRANSISTORS Q801 AND Q802. SPACE BETWEEN IS EXAGGERATED IN INTERESTS OF CLARITY.

Fig.10 VU component overlay (Note LK1 not made, LK12,13 &14 made)

pure sine waves. This is coupled to a precision switched attenuator and can be built either on breadboard or Veroboard and used for the setting-up of the PPM. It was first featured as part of a design for a distortion meter/spot oscillator in ETI, January-March 1985 and I believe that both photocopies of the original article, and the PCB for the oscillator in question are still available. The only alterations to the original design are a resistor in the feedback loop of the final op-amp (to bring output level up to the required 775mV) and minor alterations to the attenuator (so that attenuation steps are 10dB rather than 20). Resistor values have been changed to fake the output voltage at each level, so that the conditions found emulate those which would be present when using a 600R oscillator with 600R terminating resistance.

For those not wishing to build the oscillator, a slightly nefarious way of lining up the unit is to remove IC801 from its socket and attach a wire to the hole for pin 7. Then, with reference to the line-up voltages specified for this test point in Table 2 of Figure 12, inject the relevant DC voltage into this point and line-up as per the following instuctions, altering the DC voltage rather than the oscillator output level, when a change is required.There is also the problem of providing a suitable power supply (if the unit isn't to be kept and used with the AutoMate itself). An ideal power supply to use is the one developed for The Nightfighter, a fledgling project of mine from last year. It has split supply rails for all of the op-amp circuitry and the 5V LED supply. The 5V supply can be dispensed with if the unit will only ever be used in 'dot' mode. In this instance, current consumption of the unit is reduced with fewer LEDs on - and so they can be powered from the common 12V rail rather than from a separate one. In true AutoMate style, the audio and switching power supply rails have been kept entirely separate. Should the module be built for a unit other than the AutoMate mixer, both of the appropriate rails - audio and switching - can be commoned together, either at the board end, or at the PSU.

If the unit is to be switched between 'dot' and 'bar' mode, a separate supply rail *must* be used or the 660mW maximum power dissipation of the bargraph driver IC's will be exceeded, causing their immediate destruction.

To set the unit up, double check once more that all of the ICs have been inserted correctly. (The bargraph chips aren't labelled as such with a pin 1 detent - very remiss of NSC. Pin 1 is, the one at the top left hand corner of the device when the writing printed along one side is on the left). They are correctly mounted when the board is component side up and the writing along the edge of the modules can be seen. Now set all of the preset pots to their mid positions. In the case of cermet multi-turn presets, where no visual indication of the wiper position is given, use a trimmer tool to turn the actuating screw clockwise until the slipping clutch action of the mechanism is felt or heard. Now, wind the screw back anticlockwise ten complete turns - the cermets are of the twenty turn type and this should now be their approximate mid-position. Connect power to the unit as per the pin-out on the component overlay and, then connect either a source of programme or the output of the oscillator to the PPM input terminals. If a 'scope is available, look for a rectified version of the input on pin 14 of IC 801. Pin 7 of IC801 should have a smoothed, positive-going version of this. If all is well, turn off the power.

The first operation which must be performed is the nulling of the log amp. A low level input signal, lower than the envisaged lowest which the meter must indicate, should be applied to the input while this is being done. A level of -30dBu or lower normally suffices. This should come from a signal generator calibrated in dB's or from the oscillator design shown in Figure 13. Using a 'scope, preferably, or a moving coil multimeter such as an AVO, adjust PR801 for approximately 0V on pin 6 of IC 802. There will come a point during the null procedure when the 'scope trace or meter pointer flies full-scale. The point of correct null is just before this happens. With a -30dBu sinusoidal input, the op-amp can be considered approximately nulled when there is a reading of around -0.44V on pin 6 of IC2. Now, using the DMM, measure the voltage on pin 7 of IC803. This should be around 3.42V. Adjust PR802 until this is so. Transfer the probe to pin 1 of IC803 and adjust PR803 for around 0.11V on this pin.

Next, apply zero level (0dBU) tone to the input. There should be around 2.11V on pin 7 of IC801, -0.74V on pin 6 of IC802, 1.58V on pin 7 of IC803 and 1.94V on pin 1 of this IC. Reducing the level by 10dBU should cause five of the LED's to extinguish. If this is not the case, adjust PR802, constantly flicking between 0 and -10dBu to verify this. Once the setting of the preset is deemed correct, reduce the input level by a further l0dBu and verify that a further 5 LED's have gone off. The scale is now set for 2dB per division. Reduce the level further to check that the bottom-most LED extinguishes. If it doesn't, adjust PR80l null control until it does. Then check that the scale factor is as before. Finally, input zero level tone again and adjust PR803 for the desired full-scale deflection. Now all that remains is to check whether the Bar/Dot switch operates as it should. All of the above readings assume use of 17V split supply rails. These readings hold good when the unit is used with 9V, 12V and 15V rails, although the presets will need to be re-adjusted if the supply rails are changed. When units are cascaded, scale factor and FSD for each of the units is altered from its stand-alone value. The differences, assuming two units in cascade, 1dB/division and FSD of 10dB, are shown in Tabulated form in Figure 12. Cascaded displays follow the same procedure, but with PR802 adjusted initially for a reading of 3.3lV on pin 7 of IC803 (with zero level tone inputted) and 3.64V on pin 1 of the same IC. This gives a convenient 1dB per division scale factor. As mentioned in the How It Works section, the bargraph modules are very susceptible to hum loops and earthing arrangements. With one PCB, the grounding has been optimised. This is no longer the case when two or more boards are connected together. The 'ground follows signal' arrangement must be followed, with the earth wire from the bottom-most module daisy-chained along to each succeeding board. Failure to do this causes shifts of the reference voltages of boards further 'along the line', to such an extent that levels indicated can be different when the display is switched between bar and dot mode. Also, segments of succeeding stages light before they should. No amount of decoupling was found to cure any of these problems, though proper earthing did. A piece of suitably-shaped celluloid or gel (red for green modules, green for red) creates a contrasting colour.

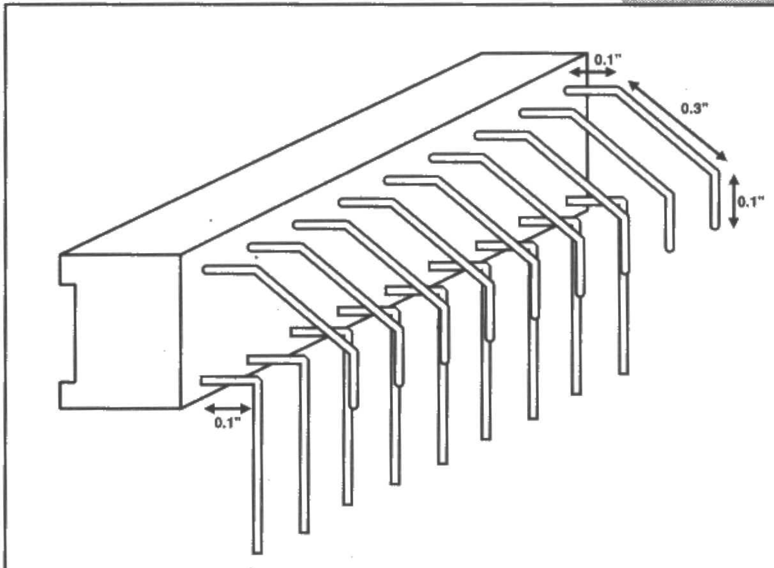


Fig.11 Detail of bends for bargraph IC holder

Capacitor C802	Capacitor Type	R801, 2, 3	R804, 5	R806	Time Constants			Mounting Position	RS Order Code No.
					Attack ms	Decay s	Tolerance		
4u7	tantulum	110k	220k	390R	1.833	1.036	+/-10%	A	104-685
4u7	radial elect	110k	220k	390R	1.833	1.036	+/-20%	B	107-381
4u7	min poly dipped	110k	220k	390R	1.833	1.036	+/-10%	C	115-629
4u7	metal poly film	110k	220k	390R	1.833	1.036	+/-20%	C	113-601
3u3	radial elect	150k	300k	560R	1.804	0.992	+/-20%	B	
2u2	min poly layer	150k	300k	820R	1.804	0.662	+/-10%	A	114-446
2u2	min poly dipped	150k	300k	820R	1.804	0.662	+/-10%	C	115-613
2u2	polycarbonate	150k	300k	820R	1.804	0.662	+/-20%	C	114-620
2u2	radial electrolytic	150k	300k	820R	1.804	0.662	+/-20%	B	
2u2	metal poly film	150k	300k	820R	1.804	0.662	+/-20%	B	113-594

Fig.12a Table of component values for various types and sizes of time constant capacitor C802

	Input Condition			
Test Point	-30dBU	-20dBU	-10dBU	0dBU
IC801 PIN7	0.061V	0.203V	0.66V	2.11V
IC802 PIN6 (Adjust PR801)	≈-0.44V	-0.49V	-0.57V	≈-0.74V
IC803 PIN7 (Adjust PR802)	3.42V 6.82V	2.77V 5.56V	2.16V 4.41V	1.49V 3.31V
IC803 PIN7 (Adjust PR802)	≈0.11	0.76V 1.44V	1.37V 2.56V	1.94V 3.36V

Fig 12b Table of calibaration voltages

Mode Select

This is the really clever part of the IC and is used to control the bar and dot modes of operation, as well as more importantly from our point of view, the correct display operation when devices are cascaded. In single device operation, tying this pin to V+ gives bar mode while leaving it open circuit yields a dot display. When cascaded together, bar mode control for each individual IC remains the same. The versatility of the IC is not fully realised until drivers are cascaded in dot mode. The reference output of the lower IC is connected to the REF ADJ/R pins of the IC next along the line, so that, for example, the first driver will respond to 0 to 1.25V inputs and the second to 1.25V to 2.5V inputs. Consider what might happen should a 1.5V input be applied. It lies within the threshold range of the upper IC and so will light LED 2 only (in dot mode). It will also, however, cause FSD of the first driver which will cause LED number 10 to light.

What we actually want is LED 10 to be switched off when the input voltage is higher than the upper threshold limit for that device. Special circuitry has been incorporated into the

IC to do this. Cascading devices in dot mode involves connecting the Mode pin of the lower driver to LED1 pin of the upper. This holds true for however many devices are cascaded, with the last Mode pin left open circuit or connected to Pin 11. Causeing LED10 of the lower device to shut off when LED 1 of the upper device lights.

As long as the input signal is below the threshold of the second driver, LED 11 is off. The mode select pin sees, in effect, an open circuit, which causes driver number 1 to operate in dot mode. As soon as the input reaches the threshold voltage of LED 11, the Mode pin of driver number 1 is depressed by one LED voltage drop, which is sensed by a comparator referenced 600mV below V. This forces the output low, shutting off the output transistor and turning LED

resistors for each LED. Aside from the space considerations which 20 further resistors would cause on an already-cramped PCB, it is a method which is not applicable to the bargraph modules, since individual LED anodes and cathodes are not available externally on these.

Instead, our design drives the LEDs from a separate, low voltage 5V supply. Chip power dissipation with this arrangement is below the maximum specified.

The heavy currents drawn in bar mode can cause problems if grounding rules are not followed, as the currents flowing out of the module ground pin cause voltage drops in external wiring and hence errors and oscillations. Liberal decoupling of the supply rails, to the ICs improves matters considerably. C806 to 810 provide this function.

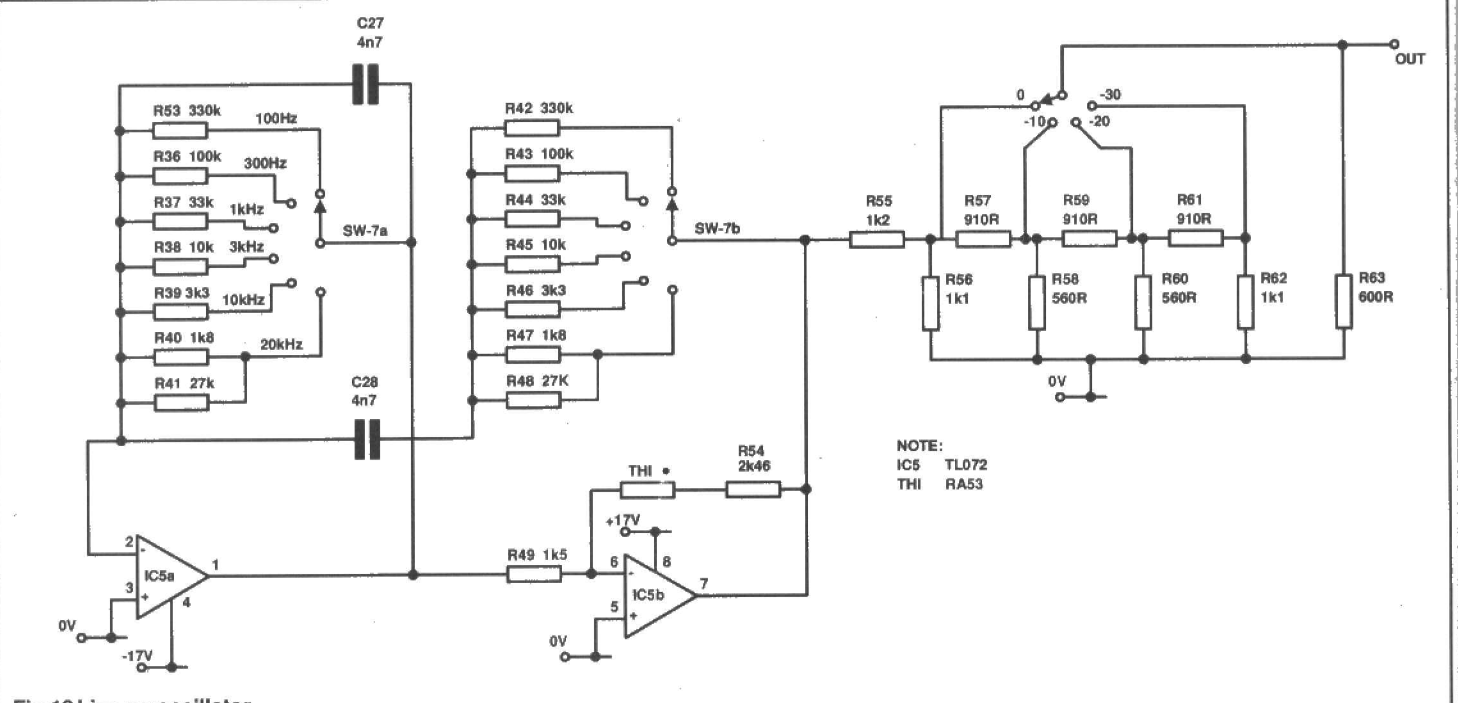


Fig.13 Line-up oscillator

10 off. V is sensed by the 20k resistors, R822 and R825 connected to pin 4 on each module. The very small current shunted as a consequence (around the 100μA mark), has little noticeable effect on LED intensity.

Maintaining a low current flow through LED 11 (via R822, 825) even when the input voltage is such that the LED is, in fact off ensures that the Mode pin of driver 1 is held low enough to force LED 10 off when any LED further up the chain is illuminated. Unfortunately, the 100μA flowing from this point has one troublesome side effect. Sometimes, this causes discernible illumination of LED 10 when high efficiency packages are used. Shunting the LED with a 10k resistor cures the problem, since the 1V drop is more than the 900mV worst case needed to hold LED10 off, though small enough that LED 11 shows no significant conduction. R823 and 826 facilitate this. We've concerned ourselves primarily with dot mode at the present, but bar mode yields some unique problems of its own. The module has a maximum power dissipation rating of 500mW. Even with low programmed LED currents, this rating is easily exceeded in bar mode, when many of the LEDs will be lit. There are two ways of tackling the problem. One is to run the IC and LEDs from a common positive supply rail, but with current limiting

Cascading Boards

For cascaded boards, it was necessary to make the following pins externally available: Ref Adj/R , Ref Hi/R Signal In/Out, and LED 1, LED 9 for the necessary dot mode sensing (Mode In and Mode Out on the diagrams). When the board is used singly, a link LK11 connecting Ref Adj/R to 0V is made on the board (this is also true of the lowermost board in a cascaded arrangement). All other pins are left unconnected. In cascade mode, Ref Out/R is connected to Ref Adj/R on the next upper board, Sig Out is connected to Sig In and the mode pin is connected to LED 1. Unless the switch connections are brought from the board to a multipole switch, Mode will need to be changed simultaneously on each individual board. Only one rectifier/time constant/log amp/level shifter is required to drive all of the cascaded sections. As boards are cascaded, the effective reference voltage from the Ref Out pin is higher. This voltage programmes the LED 'on' currents. Higher voltages necessitate higher resistor values. R821 and 824 must be altered in value on any cascaded boards, to the extent that Vref/R prog = 10mA. Since Vref alters by 1.25V in every succeeding module, R821 on the second board would be 3k6, R824 would be 4k8 (R preferred = 4k7) and so on.

PROJECT

VU Option

Provision has been made on the board for the fitting of the components necessary to recreate a VU-type ballistic response. The VU is a relatively slow full-wave averaging type, as we've already discussed. The ANSI specification calls for the meter to reach 99% deflection in 0.3s, with a 1 to 1.5% overshoot. This is met by an underdamped second order response with a resonant frequency of 2.1Hz and a Q of 0.62. Figure 7 shows the circuit. Capacitors C801 and 802 and resistors R801 to 806 are altered from their PPM values, with C803 now added and D803 and 804 omitted. The amended layout is shown in Figure 10.

I mentioned in the main text that there just wasn't enough space on one board to provide both VU and PPM characteristics as a switchable facility. With two boards, this becomes possible. One board is built with a PPM front end stage while the second is constructed using VU components. The signals from both stages are brought off the board and into a SPDT switch, with the common terminal connected to IC801 pin 5 on whichever board the log amp and associated circuitry are fitted. If the audio input is paralleled to both boards, the switch can be used to alternate between VU and PPM ballistics. See Figure 9 for further details.

Using the Meter

The meter can be fitted and used with just about any kind of audio equipment. It is quite sobering to connect it to the line output of an FM tuner and to see just how small the dynamic range of broadcast material is - about 24dB on BBC stations and even less on some of the commercial stations. When the meter is connected to the output of a cassette deck, it shows the restricted dynamic range of this medium too. A further use is as a pocket level meter. In dot mode, current consumption is low enough to be used with PP3 batteries (although they don't last too long). This arrangement is useful for verifying the presence and level of a signal (perhaps at the end of a lead).

If you've constructed two meters, one with VU and one with PPM ballistics, it is useful sometimes to line them up identically and then apply the same programme source to them. In this way, it is self-evident just how much difference in indicated reading there is between the two meter types.

One final point. Last months cover photographs are of the original prototype. Component values, types and placings may alter slightly from the design shown here, which is a more streamlined, second generation version.

References

Radio Spares Data Sheet No. 3835

An Introduction to Practical Electronic Circuits - Integrated Circuit Building Blocks (Martin Hartley Jones).

BUYLINES

Capacitors are available from RS Components (order codes in Figure 12), as are the wirewrap sockets (Order No. 402-276) and the sub-miniature right-angled PCB-mounted toggle switch (Order No. 664-401). The bargraph modules are available from Farnell (Order No. TSM 39341 (red) and TSM 39342 (green). Capacitors from other suppliers will probably fit in the PCB holes provided - take the board along with you to the shop!

A full kit of parts (excuding PCB) is available from the author. Price £29.00 (incuding switch) or £26.50 (excluding switch). Please specify whether you require the VU or PPM type. Write to:

22 Cintra Ave, Reading Berks RG2 7AU. Make crossed cheques payable to the author and allow 28 days for delivery. Orders outside the UK should also enclose two international reply coupons.

PARTS LIST

RESISTORS

R801-3	110k or select from Table 1 (*PPM only - see text)
R804,5	220k or select from Table 1 (* PPM only- see text)
R806	390R or select from Table 1(* PPM only- see text)
R807,8,11,17-20,23,26	10k
R809,10,16	1k
R812	470R
R813	10M
R814	22k
R815	2k2
R821	1k2
R822,25	20k
R24	2k4
PR801,3	10k miniature vertical multiturn preset (side actuating)
PR802	50k miniature vertical multiturn preset (side actuating)

CAPACITORS

C801	220n polyester (* PPM only - see text)
C802	4µ7 solid electrolyte tantalum or select from Table in Fig 12 (* PPM only - see text)
C803	In polystyrene C804 2n2 polystyrene C805 omitted in PPM version
C806, 7	4µ7 25V miniature radial electrolytic
C808, 9	4µ7 25V tantalum bead
C8l0	10µ 25V miniature radial electrolytic

SEMICONDUCTORS

IC801	TL074
IC802	TL071
IC803	TL072
IC804,5	TSM39341 (green) or TSM39342 (red)
IC806	SSM2210 (optional - see text)
Q801,2	ZTX108C (optional - see text)
D801-2	1N4148
D803-4	1N4148 (* only for PPM - see text)
ZD801,2	8V2 400mW Zener

MISCELLANEOUS

SW801	horizontal PCB-mounting DPDT ultra-miniature toggle switch (see text and Buylines)
PL1	10 way right-angled Minicon socket PCB, DIL IC Sockets to suit (8 pin, 14 pin,) DIL 18 pin wirewrap sockets (see text and Buylines), PCB, Veropins, suitable power supply (see text)

Optional Additional Parts for VU version

RESISTORS

R801,2	20k
R803	150k
R804	300k
R805	100k
R806	43k

CAPACITORS

C801	47n polystyrene
C802	2µ2 polycarbonate
C803	56p polystyrene

Low Voltage Circuits

by Douglas Clarkson

With more and more electronic and computing equipment being designed and manufactured as portable battery operated equipment, there is a move towards utilising a 'new' 3.3V logic standard. Major chip manufacturers are poised ready to take advantage of the expected surge in demand for such devices.

While there has existed a standard for 3.3V logic for nearly a decade, the dominance of the TTL 5V standard has been driven by very large device volumes during this period. As, however, suppliers of portable computing equipment try to increase battery life, 3.3V logic is proving extremely attractive. The move to 3.3V logic reduces power requirements by around 50% and where, for example, fewer batteries are required, equipment can be made smaller, lighter and cheaper.

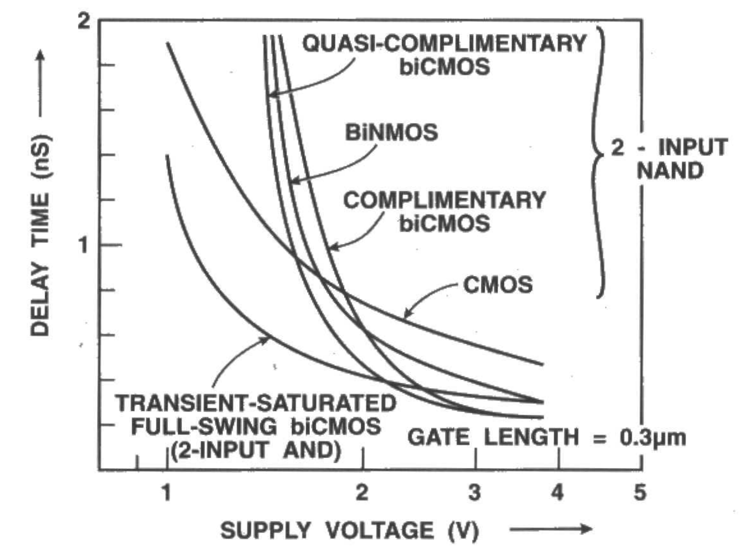


Fig.1 Variation of minimum gate oxide thickness as a function of gate length for various power supply limits in the development of high density memories.

There is, nevertheless, an awareness, that while the 3.3V is gaining favour, it may in time be replaced by even lower values. Designers are looking to extend as far as possible the range over which devices function. This is especially true of support chips.

Digital circuits require extensive support devices and manufacturers are responding rapidly with an ever increasing array of devices to meet the demand to support low voltage logic.

A growing number of linear suppliers are also providing circuits which provide the high performance of previous 5V devices with a 3V supply.

'Closed' and 'Open' Systems

In seeking to use 3.3V logic in systems, it is useful to differentiate between 'closed' and 'open' systems. A 'closed' system is one where there is no requirement to connect to additional external items. Thus the logic to control a CD player or a digital watch can be considered to be 'closed' because such items are not communicating to other systems. A PC, however, if it is connected to peripheral devices, needs to be compatible in its data transfer and handshaking with TTL and other standard voltage levels.

This leads to the concept of mixed logic design, where 'internal' circuits can work at 3.3V but circuits which require linking to external devices can be driven at TTL levels.

Achieving the New 3.3 V Standard

A range of options are available to the semiconductor designer in implementing such technology. The simplest one is to derate CMOS circuits for operating at the lower voltage. This works satisfactorily as long as all circuits operate within the 3.3V standard. Problems, however, can arise when 5V circuitry drives 3.3V circuitry.

This can be partially overcome by altering the chip design to be more resilient in such conflict situations, but the most radical solution is to undertake a redesign of the entire chip function in order to optimise a range of response characteristics. Some manufacturers are using so called SIMOX technology (separation by implantation of oxygen) to produce the substrate layers. This gives improved resistance isolation between structures and provides a 'thinner' layer of silicon to minimise possible interaction of ionising radiation.

There is a more fundamental reason, however, for the adoption of the 3.3V power supply level. Figure 1 shows that as the gate diode thickness decreases in Silicon, there is a limit voltage which if exceeded results in stress holes being punched in the oxide. There are also indications, that for gate-oxide thicknesses of less than 80 Angstroms, the power supply voltage will need to be dropped to 2.5V. It can be seen, therefore, that there are a range of factors tending to reduce the power supply voltage of digital circuits.

Various manufacturers have tried to determine the eventual limit for reduction of power supply values. Researchers at Hitachi indicate that power supply levels could eventually be reduced as low as 0.75V and still retain adequate functionality, though with increased delay times.

Figure 2 shows the complex relationships between delay time (nS) and supply voltage for a gate length of 0.3 micron over a range of differing chip fabrication technologies.

Offerings From National Semiconductor

National Semiconductor has recently announced a set of so called LVQ devices (Low Voltage Quiet). Table 1 indicates the first members of the LVQ family, but this is very much early days and the availability of such devices is limited.

Translation devices (5V to 3V) LVX244 are currently available as samples. Devices draw typically 50µA static current and can function at signal rates as high as 33 MHz. In addition, the LVQ range are available with QSOP (Quarter Size Outline Packaging) to reduce PCB footprint. Such devices are also designed to produce minimal EMI.

74LVQ00	74LVQ32	74LVQ157	74LVQ273
74LVQ02	74LVQ74	74LVQ174	74LVQ373
74LVQ04	74LVQ86	74LVQ241	74LVQ374
74LVQ08	74LVQ138	74LVQ244	74LVQ573
74LVQ14	74LVQ151	74LVQ245	

Listing of National Semiconductor LVQ 3.3V logic devices

Other Chip Suppliers

Philips has introduced the LV-HCMOS range of devices as an extension of the existing Philips HCMOS range to work at 3.3V.

Functional speeds of up to 30MHz can be achieved. To provide additional speed also at low voltage, Philips have introduced the ultra fast HLL range which can function at speeds of up to 200MHz.

Advanced Micro Devices have developed a 3 volt technology version of a 386 processor (Am386) that will allow two AA alkaline cells to power a 386 computer for up to 8 hours. This will allow further reduction in the size and weight of laptop and palmtop PC systems.

Sharp has introduced low power 3 volt Static RAM - the LH5168SHN. Using 1 micron technology the 8K x 8 static RAM consumes 1µA of standby current and 0.6µA of data retention current. This power supply requirement is a factor of 30 less than comparable devices.

Linear Technology has announced a range of devices including RS232 interface, 12bit/10bit/8bit A/D, operational amplifiers, voltage references and voltage comparators which operate from a 3V supply. It can be anticipated that such devices will be generally available from all the major linear device manufacturers before long.

PCs require extensive sets of clock signals. These tend now to be produced by PLL frequency synthesisers. Avesem has produced a device which can operate from a supply between 2.7V and 5.5V and deliver clock frequencies up to 67MHz, giving flexibility within different architectures.

LDO linear regulators are available from a range of suppliers (National, Micrel, Motorola) to provide a regulated 3V supply from a 5V unregulated supply.

Support Devices

Already a range of suppliers of support devices are providing options for 3.3V work. Datel (Basingstoke, UK), for example, have available a range of DC-DC converters delivering 3.3V from a range of input voltages.

The Maxim MAX706/MAX708 provide micro powered power supply monitoring for 3.3V thresholds, with various options providing reset at specific thresholds (2.63V, 2.93V and 3.08V).

Conclusion

During the 1990's there will certainly be a range of logic power supplies functioning within circuits. Tried and tested 5V will share space with 3.3V and possibly other, as yet undetermined, supplies may be introduced. It seems certain that portable computing equipment and other portable electronic equipment such as mobile radios will certainly take advantage of significantly reduced power requirements - resulting in even smaller systems.

It also looks like a good time to review ranges of data books stocked. There are likely to be significant changes taking place not in relation to current 5V logic systems, but in new ranges of products providing 3V functionality.

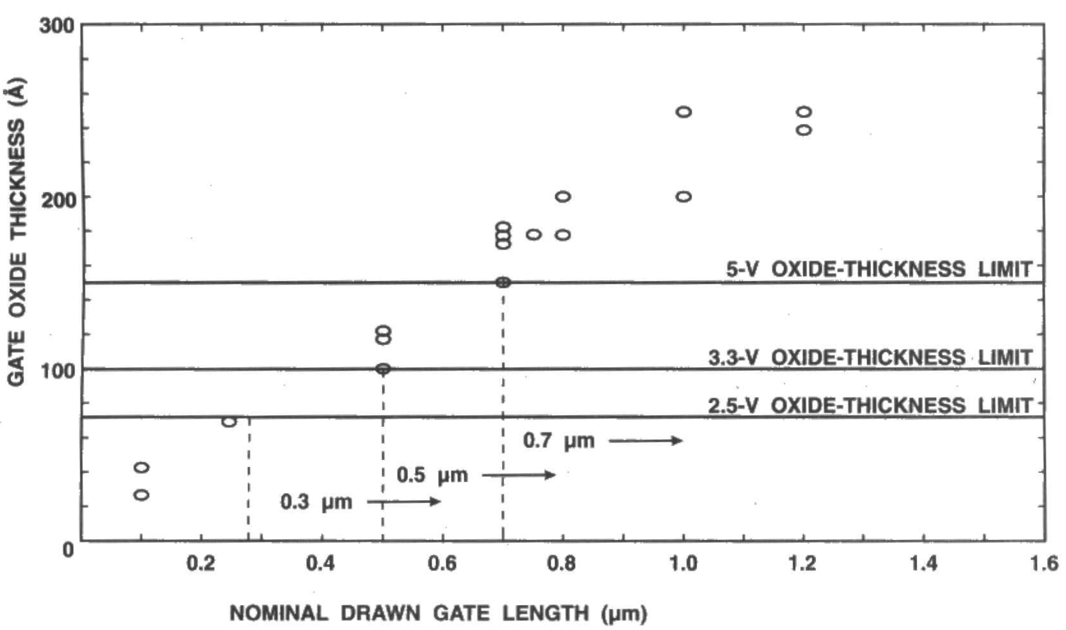


Fig.2 Variation of delay time 'ns' as a function of supply voltage for gate length of 0.3 microns across a range of chip fabrication technologies.

CIRCUITS

Infra Guide 2

Main board construction

Paul Clements continues the details of his infra-red telescope control system.

The main PCB should be constructed first, taking great care as some of the tracks are very close to component pads and if too large a soldering iron is used it is highly likely that solder short-circuits will occur. It is recommended that the PCBs be purchased as directed, since these will include the component designators in the form of a silk screen overlay, making the construction simplicity itself as only the parts list and the PCB will need to be referred to.

Solder all the passive components first, followed by the ICs.

NOTE: *The ICs are all CMOS and thus it is advisable to touch an earthed surface or conductor every few minutes or so to avoid imparting high static voltages to the ICs, which could cause internal failure.*

At all points where squares are printed, cut pins off the pin-strips and solder these in position. Note that in certain places there are rows of these squares spaced 0.1in apart, which means that the pins may be cut as a row and soldered.

When all these connections are made, the following connections must be made by hand on the underside of the PCB:

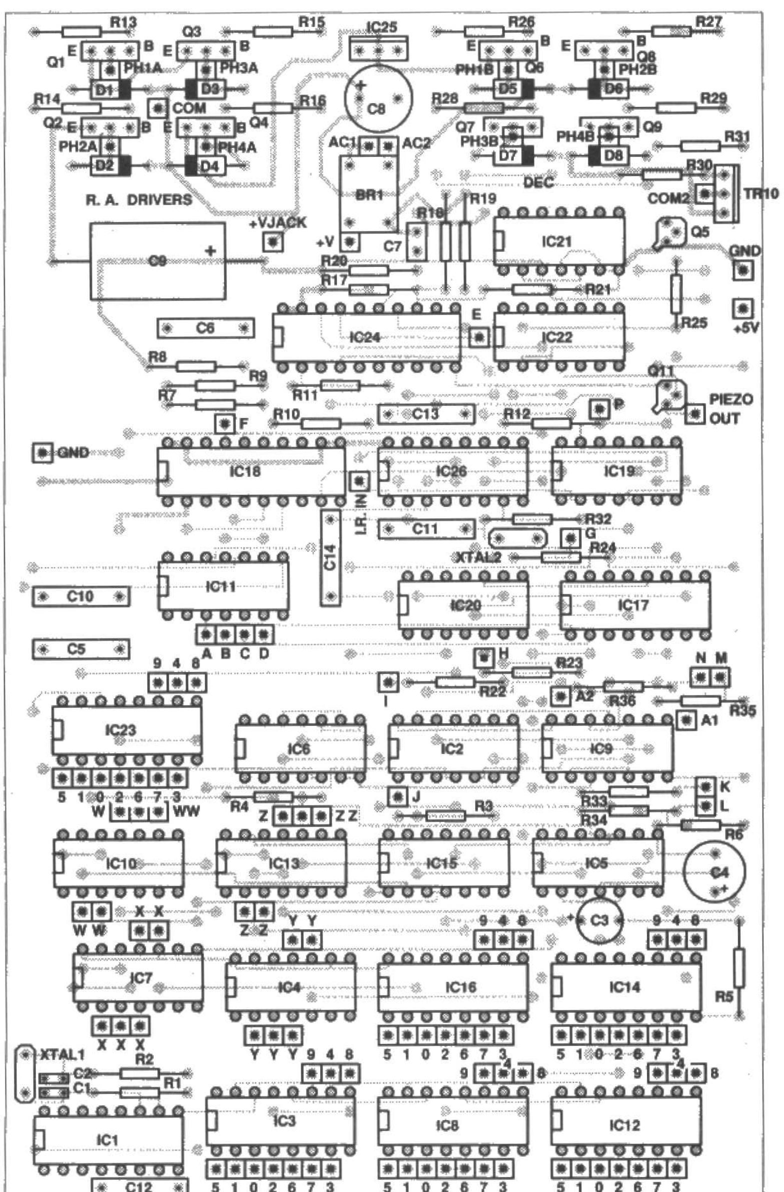


Fig.1 Component overlay of main board

1. Connect IC11 pin 2 to IC9 pin 2.
2. Connect IC20 pin 14 to IC26 pin 3.
3. Connect the leg of C11 nearest the IR IN pin to GND (there was insufficient room for these on the PCB layout).
4. Solder C15 directly between pins 7 and 11 of IC5.
5. Connect a 1k resistor directly across the terminals of the piezo electric buzzer.

Once this is done, the Y, X, W and Z inputs of gates IC4, IC7, IC10 and IC13 must be connected up, after calculating the required drive frequencies and divide ratios as detailed in the Designs Considerations section.

Remember to connect any unused W, X, Y and Z inputs to +5V, using a wiring pen for simplicity.

When the receiver pre-amplifier has been constructed, the whole system can be temporarily wired up for quick testing prior to mounting in the case:

A Connect the 5V (Vcc) and GND pins on the pre-amplifier to the same labelled pins on the main PCB.

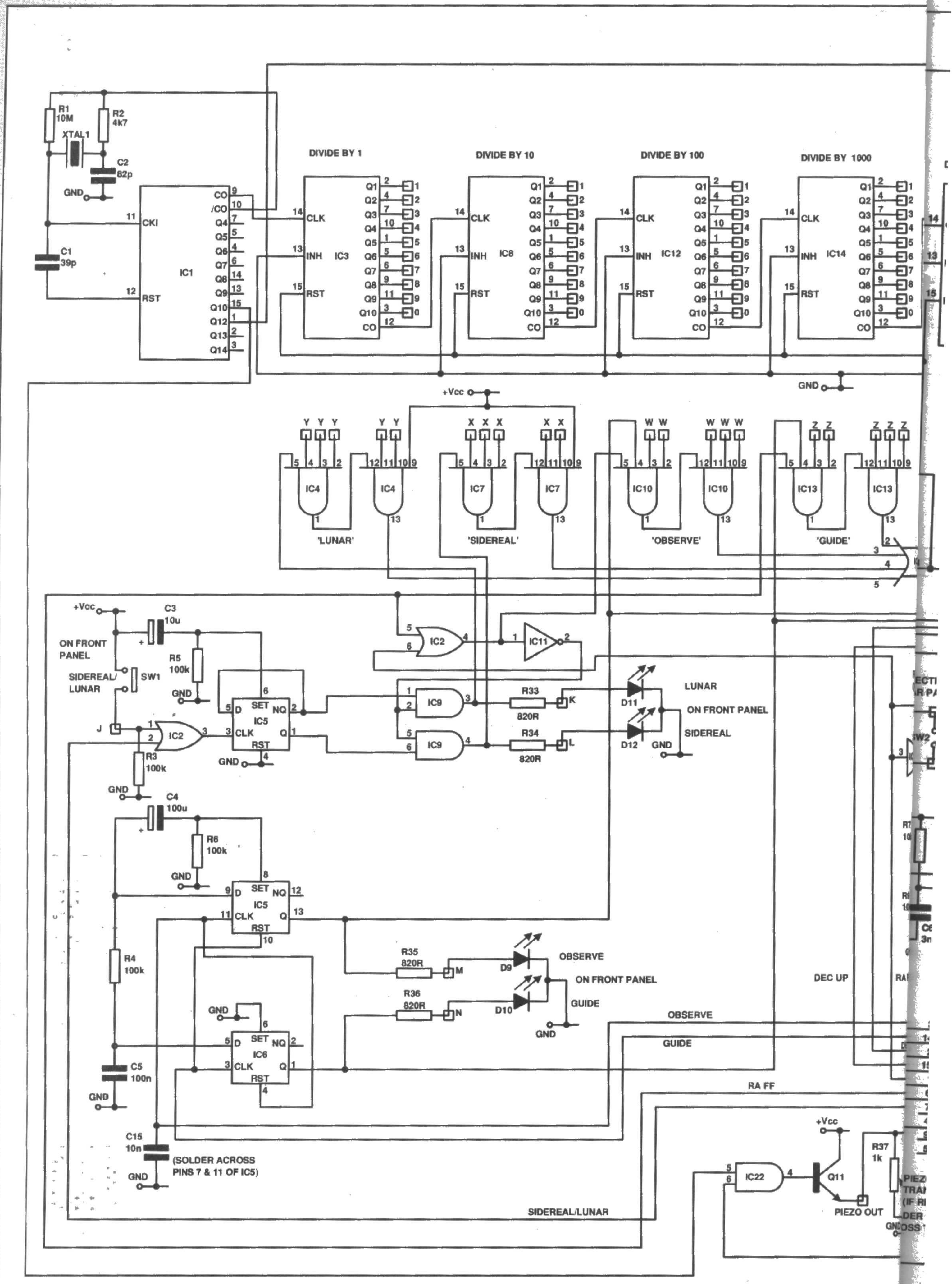
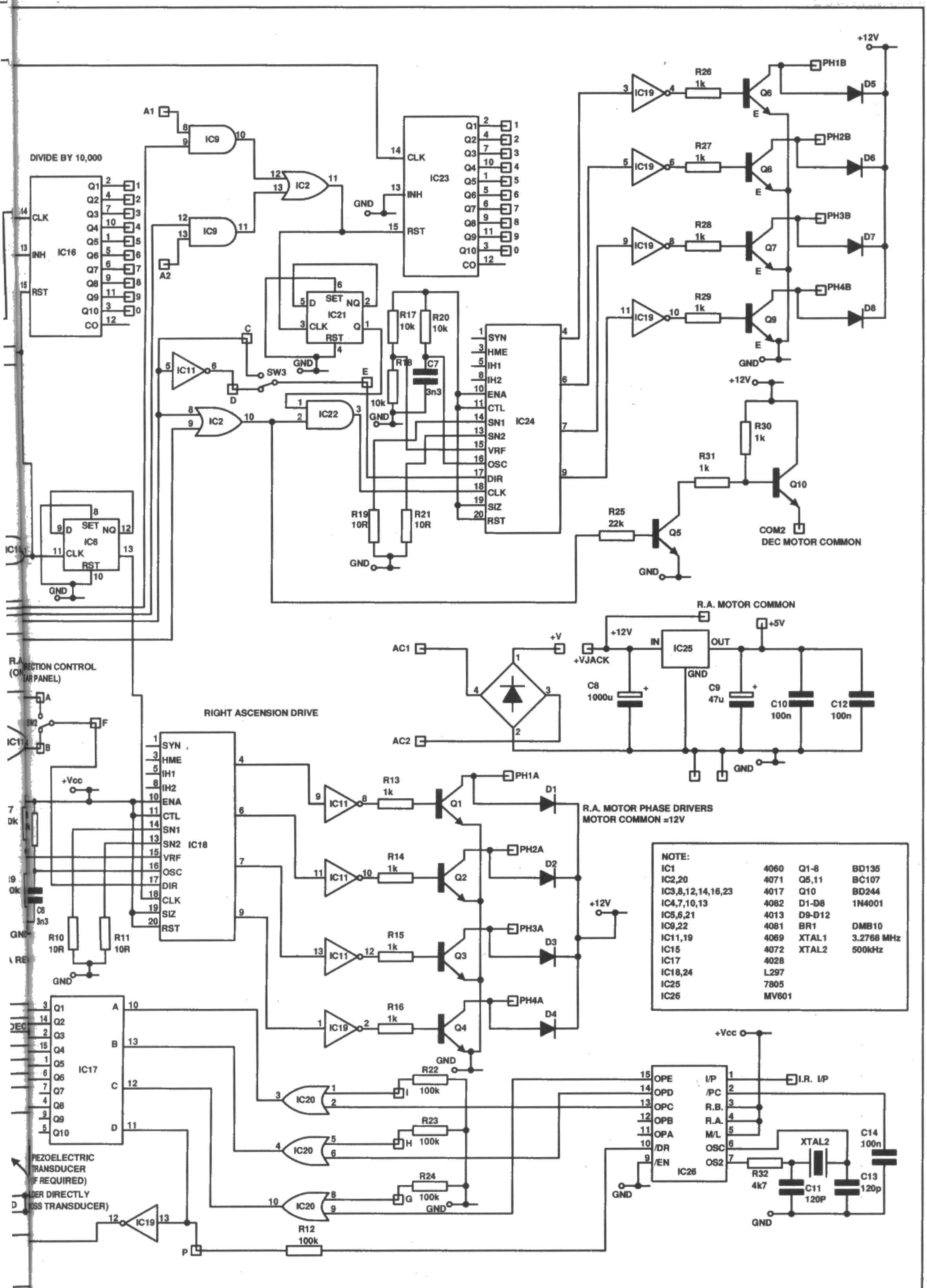


Fig.2 Circuti diagram of main board



DIVIDE BY 10,000
IC16
IC9
IC2
IC23
IC21
IC22
IC11
SW3
IC6
IC24
IC19
R26 1k
R27 1k
R28 1k
R29 1k
Q6
Q8
Q7
Q9
PH1B
PH2B
PH3B
PH4B
D5
D6
D7
D8
+12V
R17 10k
R20 10k
R18 10k
C7 3n3
R19 10R
R21 10R
R30 1k
R31 1k
Q10
R25 22k
Q5
COM2
DEC MOTOR COMMON
R.A. MOTOR COMMON
+5V
AC1
AC2
+V
+VJACK
IC25
C8 1000u
C9 47u
C10 100n
C12 100n
R.A. DIRECTION CONTROL (ON REAR PANEL)
SW2
RIGHT ASCENSION DRIVE
IC18
R13 1k
R14 1k
R15 1k
R16 1k
Q1
Q2
Q3
Q4
PH1A
PH2A
PH3A
PH4A
D1
D2
D3
D4
R.A. MOTOR PHASE DRIVERS
MOTOR COMMON =12V
C6 3n3
R10 10R
R11 10R
IC17
IC20
R22 100k
R23 100k
R24 100k
IC26
I.R. I/P
XTAL2
R32 4k7
C11 120P
C13 120p
C14 100n
PIEZOELECTRIC TRANSDUCER (IF REQUIRED)
R12 100k
NOTE:
IC1 4060 Q1-8 BD135
IC2,20 4071 Q5,11 BC107
IC3,8,12,14,16,23 4017 Q10 BD244
IC4,7,10,13 4082 D1-D8 1N4001
IC5,6,21 4013 D9-D12
IC9,22 4081 BR1 DMB10
IC11,19 4069 XTAL1 3.2768 MHz
IC15 4072 XTAL2 500kHz
IC17 4028
IC18,24 L297
IC25 7805
IC26 MV601

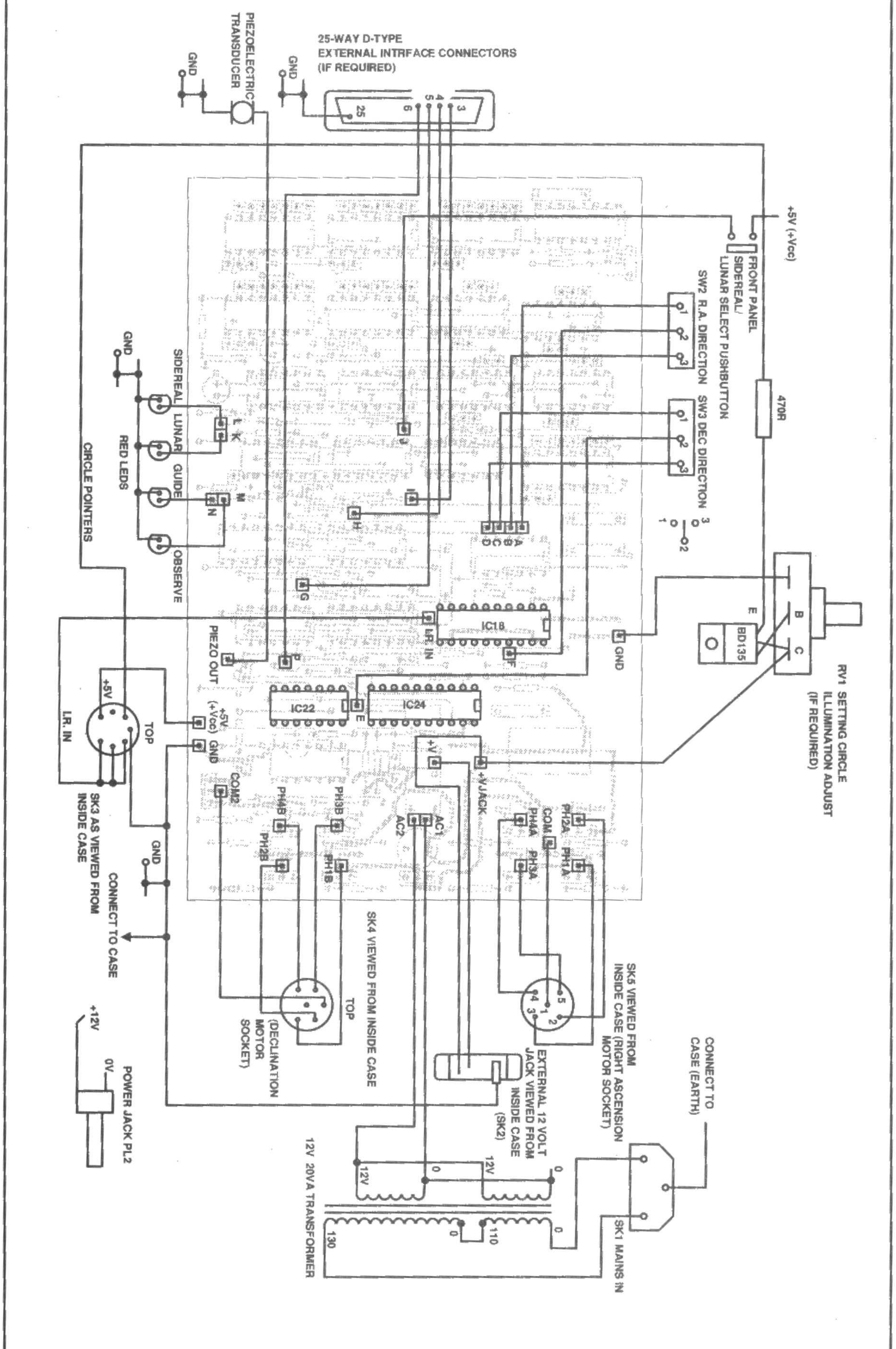


Fig.3 Off-board connections

HOW IT WORKS

The right ascension drive rates for SIDEREAL, LUNAR, GUIDE (2 times SIDEREAL rate) and OBSERVE (up to 12 times sidereal rate for rapid slewing) are produced by the crystal oscillator IC1 and the 4017 divider chain IC3,8,12,14,16. The output at IC15 pin 1 is a train of very fast reset pulses which are twice the frequency of the square wave present at IC6 pin 13.

The drive rates for sidereal and lunar are selected by pulsing the clock input to IC5a, the outputs from which enable the SIDEREAL and LUNAR and gates IC4 and IC7. Repeated pulsing of the clock input to IC5a causes the output drive rate to toggle between sidereal and lunar.

When RA fast forward or reverse are keyed, the sidereal and lunar outputs are inhibited for the duration of the keypress by the inverter IC11a.

When the RA reverse key is pressed in GUIDE mode, the RA motor is prevented from turning by virtue of the GUIDE AND gate only being enabled for RA FAST FORWARD. This allows the apparent slewing rate for fast and reverse to be the same for this mediocre slewing rate.

When the unit is first powered up, it is in SIDEREAL mode and the slewing rate is set to 12 times sidereal (observe mode). Only one front panel control is provided, this is a single switch for selecting between sidereal and lunar drive rates. This and all other functions are present on the remote control handset.

The right ascension drive frequencies are fed to the stepper motor driver IC, IC18, via the square wave generator, IC6b. IC18 is connected in half stepping mode, Q1,2,3 and 4 providing a high degree of buffering to the RA stepper motor. SW2/IC11b provide direction control of the stepper motor such that the motor may be mounted at either end of the worm shaft.

Declination drive rates for slewing at the GUIDE (SIDEREAL x 2) and OBSERVE (SIDEREAL x 12) are provided by IC23; drive rates are selected by connecting the inputs of the AND gates IC9c and IC9d to the count out pins of IC23 (this is gearbox/motor dependent and is defined in table 1 in the design considerations section). IC23 outputs a chain of very fast reset pulses is present at the clock input of IC21, which divides these reset pulses by 2 to provide a 1:1 square wave. This square wave is fed via the enabling AND gate to the stepper motor driver IC24. the stepper motor driver IC only drives the declination motor when either the DEC UP or DEC DOWN keys on the remote handset are pressed. To prevent current from being fed continuously to one of the stepper motor coils when none of the declination functions have been activated, Q5 and Q10 disconnect the motor common connection when no declination function key is pressed.

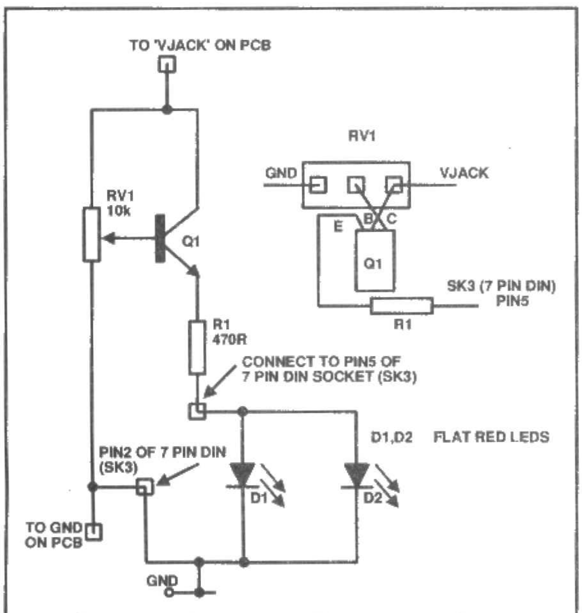


Fig.4 Setting circle pointer LED driver circuit

Connect the o/p pin on the pre-amplifier to the IR IN pin on the main PCB (between IC18 and IC26).

B Connect the motor terminals identified in Figure 2 on the right ascension and declination motors to the same terminals on the PCB.

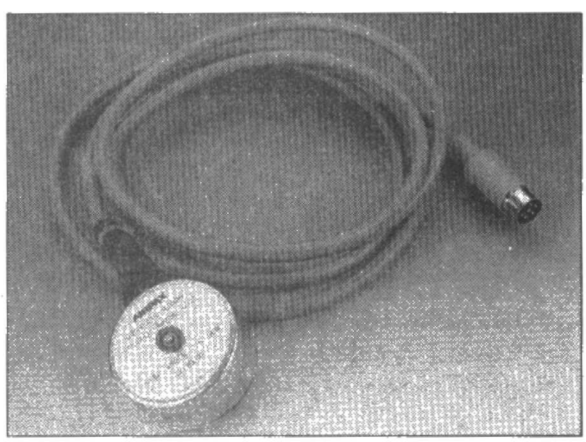
C Connect pin E (between IC22 and IC24) to pin D (beside pin 6 of IC11). Connect pin A to pin F.

D If a car battery or 12V 1.2 amp supply is available, connect this between +V jack (+12V) and GND (0V). If a 12V supply is not available, connect the pins AC1 and AC2 to the secondary of the 240V:12V mains transformer (if Farnell type 141-485 is being used, the two 12V secondaries must be connected in parallel and the two primary windings connected in series). Temporarily connect the terminals +V and +Vjack together.

E Check the PCBs for short circuits and if all appears to be OK, connect to the power supply.

The RA motor should be turning continuously, at the correct rate to drive your telescope at sidereal rate. Monitor the voltage at pin L - this should be greater than 4V. Check pins K, M and N. These should be less than 1V, greater than 4V and less than 1V respectively. Aim the remote at the pre-amplifier and press dec up. The declination motor should turn at approximately 12 times the RA rate whilst the push button is being held down.

Press dec down. The dec motor should turn at the same rate but in the opposite direction, until the button is released. Press RA ff. The RA motor should turn at approximately 12 times its default rate. Press RA rev/stop. The motor should turn at 12 times default rate in reverse.



If all these tests are OK, the system is working correctly in Observe mode. Press the guide key on the handset (aiming it at the preamplifier). Check the voltage at pin n on the main PCB, which should be greater than 4V. Press the RA ff button and the RA motor should spin at approximately twice the default rate.

Press ra rev/stop and the RA motor should stop. Press dec up and the dec motor should spin at approximately twice the default rate (while the push button is keyed), then press dec down. The motor should spin at the same rate as for dec up but in the opposite direction. Press lunar. Measure the voltage at pin L, which should be greater than 4V. A small change in the audible note from the RA stepper motor may be

heard which indicates the change in drive rates between sidereal and lunar.

If all the above tests are passed, the system is functioning correctly. Remove the links between pins A and F, pins D and E and pins +V and +Vjack.

Provided that the unit has been carefully constructed, very few problems, if any, should arise, but here is a list of possible faults and their remedies (an oscilloscope will be needed for some of these tests):

1 Symptom: system apparently completely dead, RA

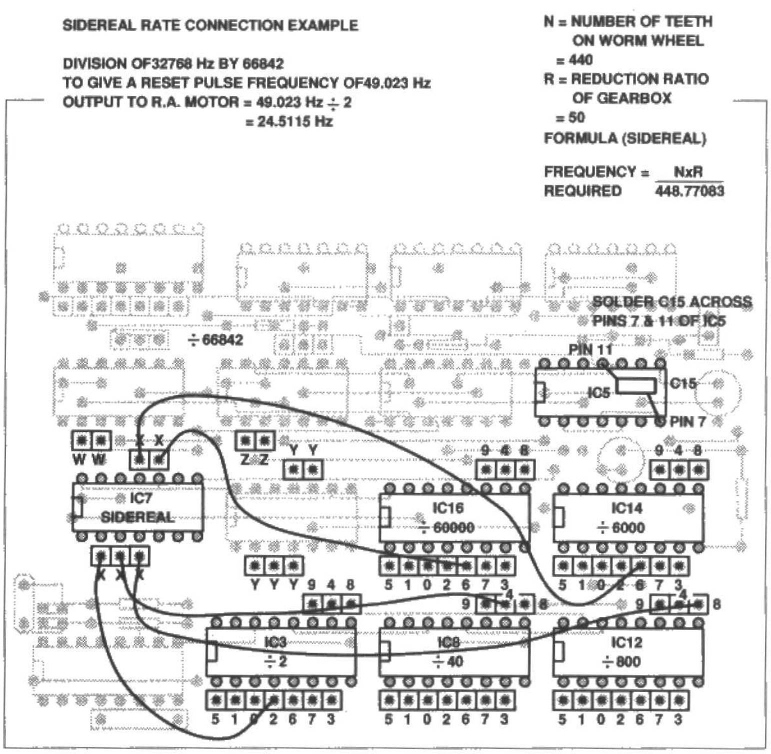


Fig.5 Sidereal rate connection example

Case Construction

It is entirely up to the constructor how the electronics are mounted, but the author recommends the use of the Maplin enclosure, the part number of which is given in the parts list. It is of a very professional appearance and reasonably priced. The metal chassis is discarded and the main PCB and transformer mounted on the base. The hole for the setting circle illuminator LED brightness pot should only be drilled if this additional facility is required.

The Sidereal, Lunar, Guide and Observe LEDs are mounted on the front panel and the RA and declination motor direction set switches are mounted on the rear panel, above the RA and dec motor sockets. Again, the constructor may have other ideas, such as using a single large connector for the RA and dec motor sockets instead of the recommended din sockets. The author has built his unit for use in an observatory and thus the need for damp protection is not as important as if the unit were to be used in the open air or lying on the ground.

Interconnecting Leads

The leads from the Infra-Guide to the motors and pre-amplifier/sensor should be at least the full length of the telescope tube. A neat shroud at the motor ends can be made by first covering with several layers of insulating tape and then covering this with a layer of heatshrink tubing.

Trouble Shooting

motor fails to turn when the unit is powered up.

Check: 5V rail at IC25 pin3. If not present, then IC25 may be the wrong way round. If there's no 12V at pin 1 of IC25 or pin 14 of IC20 is not hand-wired to pin 3 of IC26. If 5V is present then check for 3.2MHz at pin 9 of IC1. If this is OK, then the oscillator is not working - check for 5V at pin 16 of IC1. If this is OK then R1, R2, C1 or C2 are of the incorrect value or there is a fault in this area. If the oscillator is working OK, check for continuity of connections to the X, Y, W and Z inputs to IC4, IC7, IC10 and IC13. If these are right, check for a low frequency square wave at IC6 pin 13. If this is not present then there is a fault around the 4017 divider chain or IC15 or IC6.

Check the 5V power supplies to these and for good connections around the pins. If the waveform is present then there is probably a fault around IC18 - check for slow changing levels at pins 4, 6, 7, and 9 of IC18. If these are present then there is probably a wiring fault to the stepper motor or one or all of the transistors Q1, Q2, Q3 and Q4 are the wrong way round. This may also apply to transistors Q6, Q7, Q8 and Q9 or diodes D1-8.

2 Symptom: declination motor turns correctly when keys are pressed but there is no output to the right ascension motor.

Check: The right ascension functions, i.e. Lunar, Sidereal, Guide mode fast forward or Observe mode fast forward or reverse. If only one or two of these functions are defective,

PARTS LIST

MAIN PCB

RESISTORS

R1	10M
R2,32	4k7
R3,4,5,6,12, 22,23,24	100k
R7,8,9,17, 18,20	10k
R19,21,10,11	10R
R33,34,35,36	820R
R26,27,28,29, 13,14,15,16, 30,31,37	1k
R25	22k

CAPACITORS

C1	39p
C2	82p
C11,13	120p
C3,4	10u/16V ELECT
C5,10,12,14	100n
C6,7	3n3
C8	1000u/25V ELECT
C9	47u/16V ELECT
C15	10n

CRYSTALS

XT1	3.2768MHz
XT2	500kHZ Ceramic Resonator

SEMICONDUCTORS

IC1	74HC4060
IC2,20	4071
IC3,8,12, 14,16,23	4017
IC4,7,10,13	4082
IC5,6,21	4013
IC9,22	4081
IC15	4072
IC18,24	L297
IC11,19	4069
IC17	4028
IC26	MV601
IC25	7805
D1-D8	1N4001
D9-D11	5mm RED LED
Q1-4,Q6-9	BD135
Q5,11	BC107
Q10	BD244

BR11.5A,50VRRM Bridge rectifier

TRANSDUCER

Piezo electric transducer, Maplin type FM59P

TRANSFORMER

T1 240V:12V 20VA

MISCELLANEOUS

Pin strips 36-way cuttable 36-way 0.1 spacing, 4 off
Panel mountings for the 5mm LEDs, 4 off, Farnell type 170-808

SW1	'Push to make' switch, panel mounting
SW2,3	SPDT Toggle
SK1	3 PIN IEC mains inlet socket, panel mounting
SK2	Small DC Power jack, panel mounting - See Buylines
SK3	7 PIN DIN Socket, panel mounting
SK4	6 PIN DIN Socket, panel mounting
SK5	5 PIN DOMINO DIN Socket, panel mounting
PL2	DC Power jackplug to mate with SK2 - See Buylines
PL3	7 PIN DIN Plug
PL4	6 PIN DIN Plug
PL5	5 PIN DOMINO DIN Plug
SK6	25-WAY D-Type Socket
M3	Screws ∞25
M3	Nuts
M3	Shakeproof washers
M3	Spacers ∞6

IEC Mains lead
5-Way cable for connection to stepper motors, 5m minimum twin screened cable for connection to preamplifier and seeting circle illuminators.
Printed circuit board (double sided plated through holes)
Photo resist PCB for handset and infra-red pre-amplifier PCB's

OPTIONAL SETTING CIRCLE LED DRIVER PARTSLIST

RESISTOR

R1	470R
RV1	10k

SEMICONDUCTORS

Q1	BD135
D1,2	FLAT RED LED See Buylines

check the connections to the Y, X, W, and Z pins and check that any of these pins that are unused are connected to +5V. If none of the right ascension functions are working, check that the connections to the motor are correct and that the transistors Q1, Q2, Q3 and Q4 are the right way round. Check that D1-4 are also inserted correctly and for +5V supply to IC11 pin 14. Check the components around IC18 (R7-11, C6). Check that when Observe is keyed, the voltage at pin m is greater than 4V. If it is not, there is a fault around IC5 or IC6.

Check that when the Sidereal/Lunar button is keyed, pin 4 of IC17 goes high for the duration of the key press. If it does not happen there may be a fault in the remote control handset. Check that IC19 pin 12 goes high (greater than 4V) when any key of the remote control is pressed.

3 Symptom: All right ascension functions work but there is no drive to declination motor in Guide or Observe mode.

Check: That pins A1 and A2 are connected up as in

BUYLINES

Recommended sources of unusual components TSIP5200 (Infra red emitter diodes used in the handset), 2 off Farnell 178-544
Mounting clips for TSIP5200, 2 off Farnell 233-547
Ultra bright led for use as "red torch" in handset (D3), 1 off Farnell253-649
Mounting clip for ultra bright led, 1 off Farnell 179-037
Infra red receiver diode (on preamp pcb) Farnell BPW41N
Flat red LED's for illuminating setting circles Farnell MV57123-17 (2 off)
DC power jack plug and socket Farnell 224-923 Farnell 224-972
Clear mounting box for infra red reciever/preamplifier Farnell MP4511
Pushbuttons for remote handset, 8 off Farnell 151-149
Mains transformer 12V 20VA Farnell 141-485
Main PCB (double sided plated through hole and silkscreened), Handset and IR preamplifier (both single sided non-silkscreened).

Table 1. Check that pin 4 of IC21 is hand wired to pins 6 and 7 of IC21 on the underside of the PCB and that the connections to the declination motor are correct. Check that Q6, Q7, Q8 and Q9 are inserted correctly as should be D6, D7, D8 and D9. Check that Q5 and Q10 are correctly inserted and that Q10 collector goes to greater than 10V when Dec Up or Dec Down are pressed. If this does not happen, check that pin 10 of IC2 goes to greater than 4V when Dec Up or Dec Down are pressed. If it does, then there is a fault around Q5 and Q10 (possibly Q10 being the wrong way round). Check for correct component values around IC24 (R17, R18, R19, R20, R21, C7) and for short-circuits in this area.

4 Symptom: Declination motor only turns in either Guide or Observe modes.

Check: That pins a1 and a2 are wired up.

5 Symptom: Right ascension motor turns continuously when the unit is powered up but no other functions work.

Check: That when any key is pressed, pin 12 of IC19 goes high. If this does not happen, check the components and connections around IC26. If these are OK, there is a fault in either the infra-red pre-amplifier or the remote control handset. On handset: check that the infra red emitting diodes D1 and D2 are the right way round, that the ceramic resonator is the correct type, soldered correctly and that the components around it are allright. Also, check that the battery is connected! Check for pulse waveforms at Q1 collector, when each key is pressed, if an oscilloscope is available.

On the infra-red receiver, check that the connections to the main PCB are correct and that the infra-red diode D1 is the right way round. Check that the ceramic resonator on the main PCB is the same type as that on the handset.

6 Symptom: RA or dec motor shaft 'hunts' backwards and forwards.

Check: The connections to the motor phases are correct and that the connections to the bases of Q1-8 are properly soldered. Check for short circuits around IC18 and IC24.

Corrections to part one

Page 54, Column 1: 'Nearest divide ratio obtainable = 4369' should read 'Nearest divide ratio obtainable = 5573'.

Page 54, Column 2: 'As shown in Figure 1' should read 'As shown in Figure 5'.

Page 55, top left: '(see Figure 4)' should read '(see figure 5)'

Page 55, Column 1: 'As shown in Figure 3' should read 'As shown in Figure 8'.

Page 55, top right: 'As detailed in Figure 4' should read 'As detailed in Figure 6'.

Note: The minimum divide ratio allowed for RA Fast Forward (Observe Mode) = 3700. Below this the RA motor shaft will not turn.

In Use

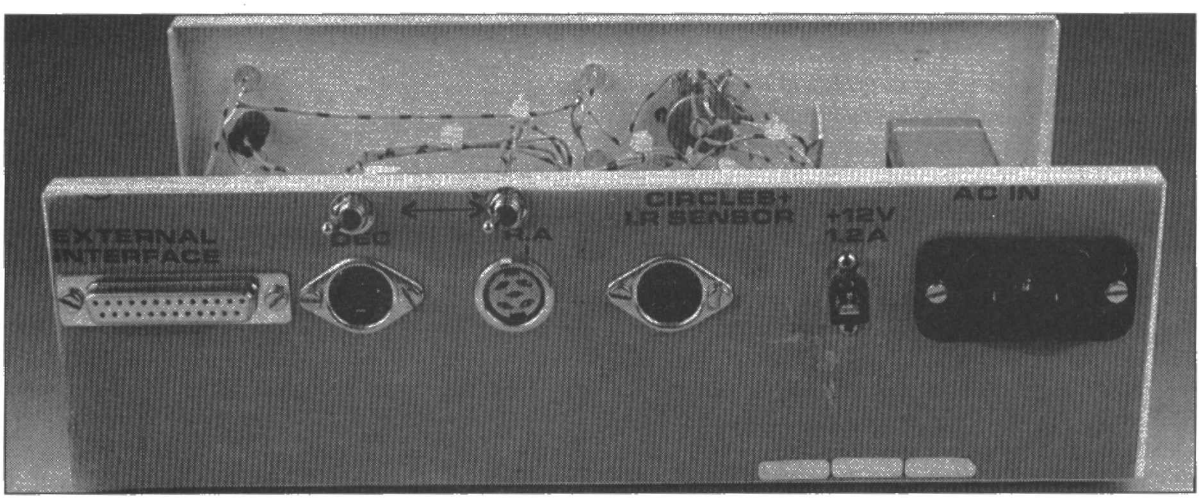
Once the construction has been completed and the unit tested inside the case, it can be attached to the astronomical telescope for which it has been custom built. The manner in which the gearboxes and motors are attached to the wormwheels must be decided by the constructor if no previous dual axis drive system was in use on the telescope. There are many different shapes, sizes and types of equatorial mounting so I will not attempt to describe how to fit the gearbox to any particular wormwheel, but Iwould suggest that the motor and gearbox assemblies be permanently mounted on the telescope and the Infra-Guide removed at the end of a night's observing and taken indoors, if the telescope is normally stored outside.

The unit can be very quickly connected and disconnected from the telescope. The sensor pre-amplifier should be mounted on a piece of velcro just beside the focussing mount such that it can be easily removed and replaced. This is actually the most sensible place to put the sensor since the user is likely to have their hands close to the focussing mount when observing. When you use it for the first time, a star should be centred in the eyepiece using the RA and dec forward and reverse keys and its motion observed under a magnification of approximately 200. If it appears not to be stationary over a few seconds, the right ascension motor is turning in the wrong direction - flick the RA direction motor switch on the rear panel. This should now be left in the same position at all times.

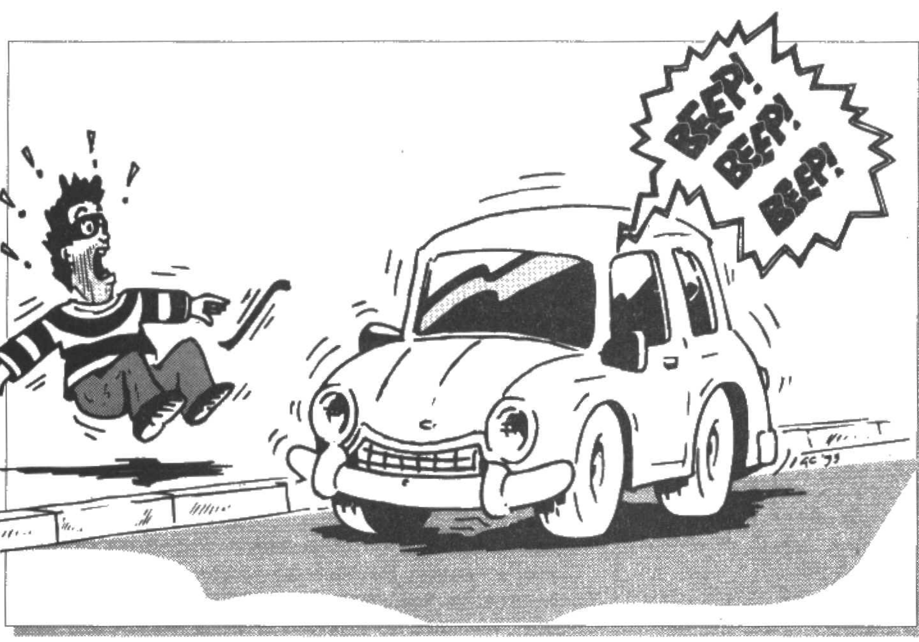
The user will quickly become familiar with the layout of the keys and the range of the handset should be around six feet.

Remote Control Interface

Input pulses from the infra-red pre-amplifier PCB are fed to pin 1 of IC26, the remote receiver/decoder IC. The first three parallel binary data bits from the decoder are used to provide the seven functions on the handset; these are fed to the binary-to-octal decoder IC17. External interfacing is achieved by virtue of ORing together the inputs to the to IC17. The outputs from IC17 drive the Sidereal, Lunar, RA fast forward, RA reverse, Dec Up, Dec Down, Guide and Observe select lines. A Receive Data OK indicator is provided by the piezo electric transducer driver IC22b/Q11. This outputs a 3kHz tone each time any of the push buttons on the handset are pressed.

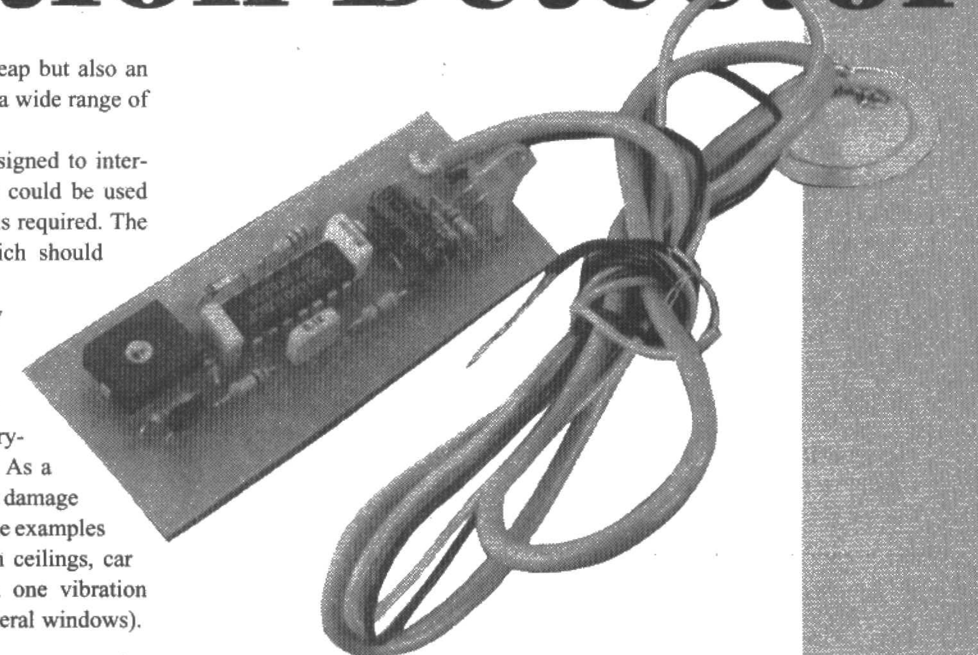


PROJECT



Protect your car, house or anything else with this sensitive instrument *by Colin Meikle*

Vibration Detector



This vibration detector is small, cheap but also an effective circuit, which can detect a wide range of vibration strengths.

The detector was primarily designed to interface with a home or car alarm system but could be used anywhere that vibration or shock detection is required. The circuit has an Open Collector output which should interface with most alarm systems.

Vibration detection is a very effective way of protecting areas which would otherwise be difficult and/or expensive to protect. It often gives a much earlier warning of an intruder, for instance detecting an intruder trying to break in, rather than after the event. As a result, if the alarm is set off early enough, the damage from the actual break-in can be avoided. Some examples of where this detector could be used are in ceilings, car chassis, alarm boxes and windows (often one vibration detector on a window frame can protect several windows).

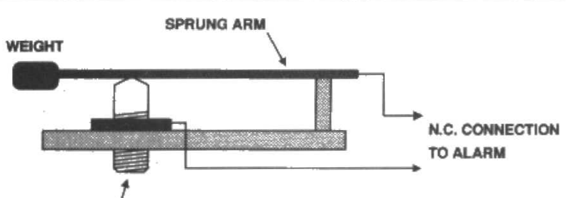


Fig.1 Mechanical vibration detector

Vibration detectors can work in a number of different ways. One of the most common is the mechanical setup shown in Figure 1. Here, a sprung arm makes and breaks with a contact, as vibrations cause it to bounce. This type of detector is often difficult to set up accurately and they often don't work well with some alarm systems (the inputs of some alarm systems are heavily damped to prevent false triggering and the small pulse widths from these detectors are often seen as noise rather than a valid signal).

Construction And Testing

Construction is a very simple procedure - just follow the component layout in Figure 3. Note that at this stage you omit R1. Use screened cable for the connection to the piezo transducer, solder the screen to the rim of the brass plate and the insulated wire to the ceramic center (be careful not to use excessive heat as this may damage the transducer). Try to keep the distance between the transducer and the PCB to a minimum.

To test the circuit, attach 0V and +12V to the PCB and connect a LED to the PCB as shown in Figures 2 & 3 (this may be left in place or removed later). When the transducer is tapped the LED should briefly flash.

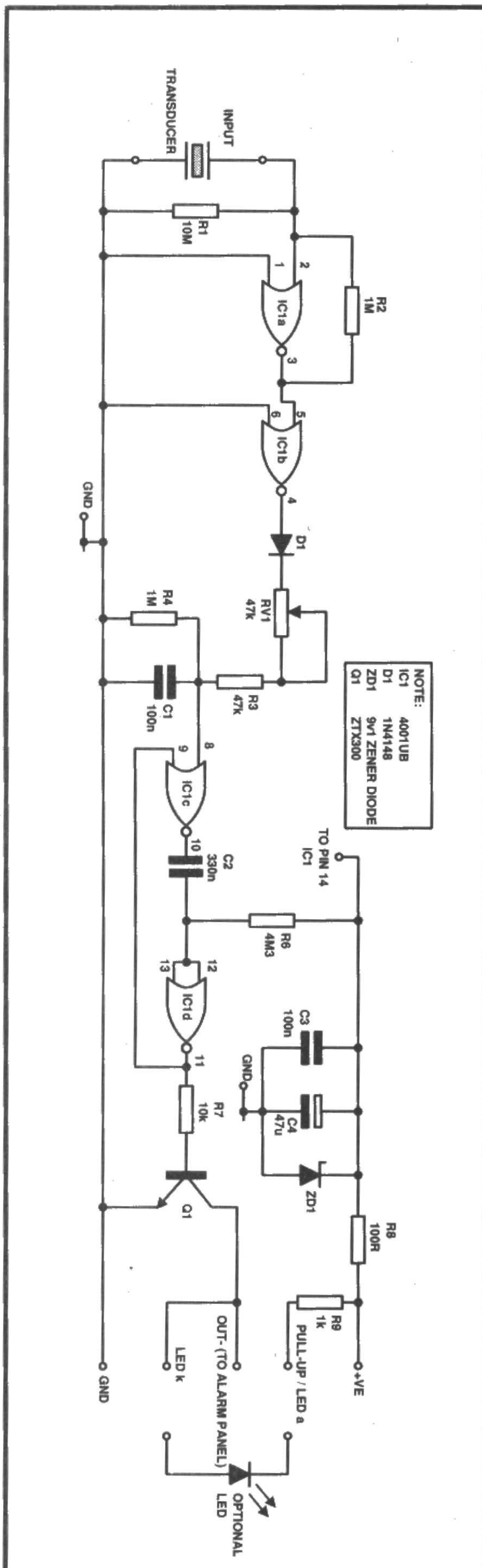


Fig.2 Circuit of vibration detector

HOW IT WORKS

Referring to the circuit diagram in Figure 2, the operation of the circuit is as follows.

The sensor is a piezo-ceramic transducer (the type used for buzzers/ sounders), which has the advantage of being small, robust and very cheap. The transducer generates a small signal when it is excited by the vibrations from the surface it is attached to. This signal is amplified by IC1a, a slightly unusual use of a digital gate as it is being used as an analog amplifier. It is important that an unbuffered 4001 is used (i.e. the UB version), as a buffered gate will not work as an analogue amplifier.

The amplified signal is rectified and passed to a simple RC network (R3, R4, RV1 and C1). By altering the time constant of this network (by adjusting RV1), the sensitivity can be altered and this has proved much more effective than trying to alter the gain of the amplifier. When a signal of sufficient amplitude and duration is detected, (when the voltage on C1 exceeds the threshold of IC1c), the monostable comprising of IC1c, IC1d, C2 and R6 is triggered, which drives the output transistor. A LED can be connected to the output, which will flash when the circuit has been triggered, to simplify the adjustment of the sensitivity.

Setting up And Installation

Setting the sensitivity of the detector is a trial and error affair and depends greatly on how the sensor is mounted.

For this reason the transducer must be mounted on the surface from where it is to operate, before any of the setting up can be done.

The transducer can be simply glued in place with a strong glue, although to obtain better sensitivity one of the methods shown in Figure 4 could be used. The sensitivity of the circuit will also depend upon the surface on which the transducer is mounted. It will work well on a metal surface, simply glued in place, but for wooden or plaster surfaces the methods in Figure 4 will give significantly better results.

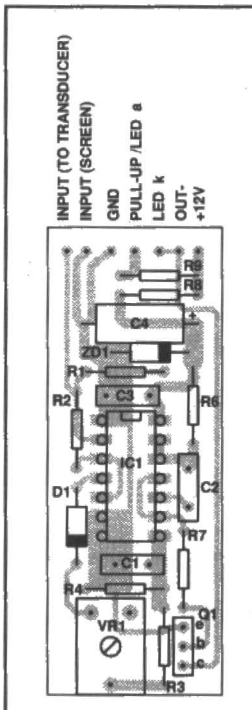


Fig.3 Component overlay

RV1 allows the sensitivity of the whole circuit to be adjusted, although it may be found that the circuit is too sensitive/insensitive. It is probably best to alter the mounting of the transducer first, as this has a large effect on the sensitivity. If that does not work or is impractical, adjust the value of C1 (increase its value to make it less sensitive or decrease it to make it more sensitive). If the circuit is greatly over sensitive, which may happen on metal surfaces, add R1 (10M), which will decrease the sensitivity.

To connect the vibration detector to an alarm panel, connect the +12V and 0V line to the appropriate power connections and connect the outline to the normally open (NO), active low, connection on the panel. If the LED is connected, it may light when other devices in the alarm circuit are activated. If 0/12V levels are required, replace the LED with

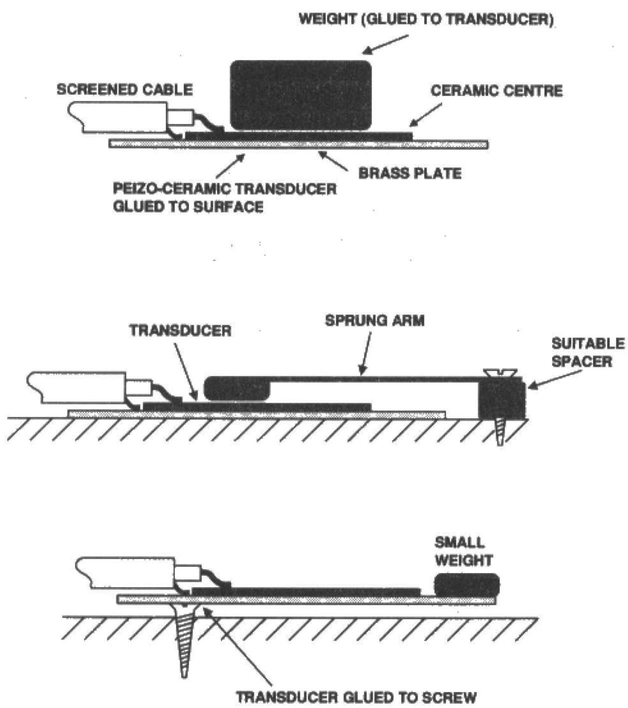


Fig.4 Mounting of Transducer

PARTS LIST

RESISTORS
R1 10M
R2 1M
R3 47k
R4 1M
R6 3M3
R7 10k
R8 100R
R9 1k
RV1 47k

CAPACITORS
C1 100n
C2 330n
C3 100n
C4 47u

SEMICONDUCTORS
IC1 4001UB CMOS unbuffered NOR gate
D1 1N4148
ZD1 9V1 Zener
Q1 ZTX300 (or any Gen Purpose NPN Transistor)

MISCELLANEOUS
Small piezo-electric transducer
LED for test purposes
Suitable lenth of screened cable

a link. This will pull the output of the circuit high when inactive. If connecting to a car alarm which uses the courtesy light door switch, the modification shown in Figure 5 should be made. A pull up may also be required on the Out-line although most alarms will not need this. If you do, remove the LED and replace it with a link. If your alarm detects voltage drops in the car's electrical system rather than the door switches, use the vibration detector to drive a relay which in turn should drive a suitable dummy load.

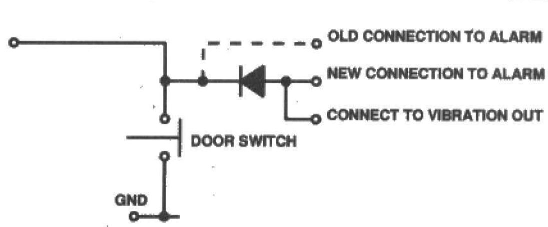


Fig.5 Connections to car alarms

Possible Problems

If the open collector output is unsuitable (for example, an alarm system which only has closed loop circuits), the output could drive a small relay. The relay contacts could then drive the required device, that is the NC contacts could be included in the closed loop of an alarm circuit.

If false triggering is a problem, it will probably be due to the mounting of the transducer. Try moving it or mounting it differently. It is also advisable not to mount any of the circuit next to other electrical equipment, as it may pick up stray signals.

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E9209-3 Temperature controller .... M
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E9302-2 Sound to MIDI Board L
E9302-3 Puddle Tec .... E
E9302-FC Infra Red Transmitter .... E
E9303-1 Ni-Cd Battery Charger .... E
E9303-2 IC Tester .... E
E9303-3 Disco Amiga (motor driver board) .... H
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E9304-2 Multimate Tester C
E9304-3 The Keepsafe Alarm .... F
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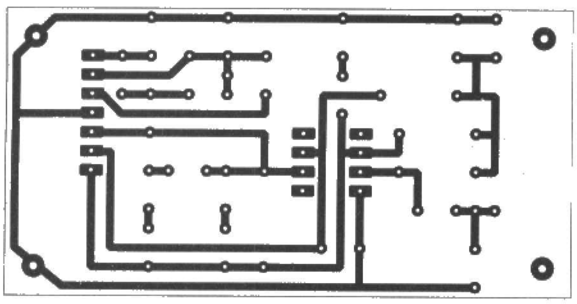
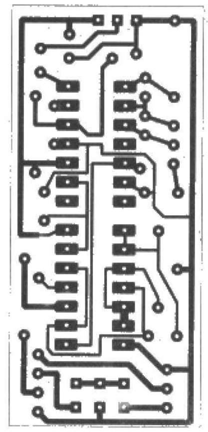
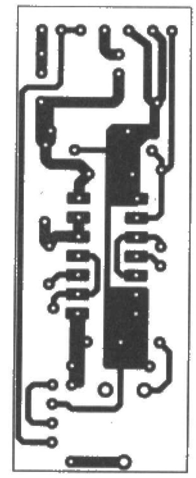


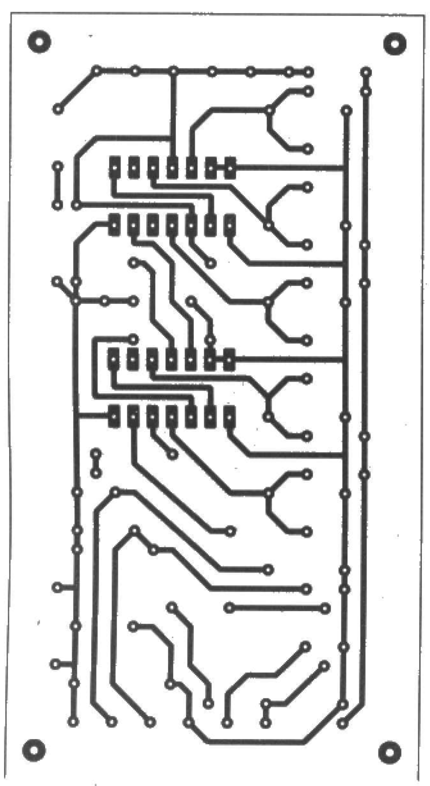
The Fuzztone



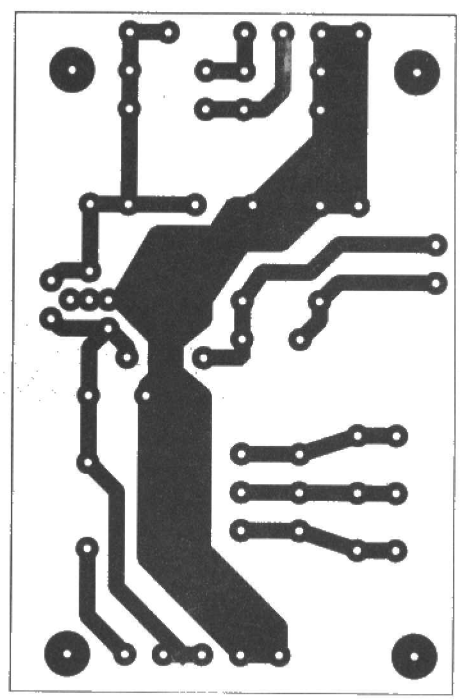
Radio Control Trafficators



Vibration Detector



Pentacode



Pentacode Relay